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THE U. S. BATTLESHIP "ILLINOIS," built by the Newport News Shipbuilding & Dry-Dock Co., made an average of 17.31 knots under forced draft, in her official speed trial of June 13. The course was 33 knots long, off Cape Ann, and the conditions were perfect, with a smooth sea. The course was marked off in 6.6-knot lengths, and in going out these lengths were made at the following rates per hour: 17.3, 16.97, 17.84, 17.8 and 17.52; the average out was 17.36 knots. On the return trip, the average was 17.26 knots. The ship steered remarkably well, and she made a complete circle in 3 m. 10 s. on a diameter of 300 yds., or, within three times her length. The engines worked perfectly; with 118 mean revolutions, or 119¼ on the spurts. The boilers carried an average pressure of 180 lbs., and the forced draft was 1 in. mean and 1¼ ins. maximum; about 50 tons of coal were used on the trip, and the fireroom temperature was about 100°. The contract speed was 16 knots.

THE BATTLESHIP "WISCONSIN," built by the Union Iron Works, of San Francisco, Cal., had a late 48-hour sea trial under natural draft, to test her seaworthiness. Under these conditions she averaged 16.45 knots for two hours, and 15.3 knots for the 48 hours. All of the guns were also tried with shot, and everything found satisfactory. But on her way down the coast from Puget Sound, and under forced draft, the "Wisconsin" is said to have made 18.6 knots for two hours.

THE U. S. DRY DOCK AT PORTSMOUTH, N. H., commenced about one year ago, is reported as about half completed. This dock will be 775 ft. long over all, 725 ft. long on the floor, 130 ft. wide at the coping, 80 ft. wide at the floor, with a depth of 30 ft. over the sill at mean high tide. The foundation excavation is in solid rock; with a granite floor 4 ft. thick laid on 12 ins. of concrete; upon this will rest the keel-stones, 4 ft. high, with their tops on a level with the sill. Three powerful centrifugal pumps, lifting 43,000 gallons of water per minute, will empty the dock in about two hours, and three electric motors will operate these pumps. The previous lack of fresh water at this yard has been overcome by the construction of a new plant; taking water from Folly Pond, in York, and leading it 14 miles in 16-in. pipes to a 100-ft. standpipe on Seavey Island, having a capacity of 500,000 gallons. The estimated cost of this plant is $100,000. A yard railway, with 10,000 ft. of tracks, is also being laid; and a number of new buildings are being constructed of steel and brick with granite trimmings.

THE CHIGNECTO MARINE TRANSPORT RAILWAY Co. is still sufficiently alive to hold a general meeting of its stockholders, as reported in the London "Railway News." All that the chairman could tell them, however, was that efforts were still being made to interest the Canadian government in the project, and there was "a glimmer of hope" that the negotiations would succeed. Meanwhile, he reported that the work already done upon the ship railway was in good condition. The old board of officers was re-elected.

THE CONTRACT FOR THE TIDAL CANAL, between San Leandro Bay and Oakland, Cal., has been awarded to the Atlantic & Pacific Dredging Co., says the Oakland "Enquirer." The quantity to be moved is 1,300,000 cu. yds., and the material has to be carried some distance by railway, to make a fill on the western front of the city. The price bid was 19.7 cts. per cu. yd. Some of the papers of San Francisco contend that all of the four bids were too high.

THE IMPROVEMENT OF THE RIVER THAMES by an American syndicate is discussed in the London "Daily Mail." At present a vessel drawing more than 25 ft. is exposed to the chance of running aground below Gravesend; and in some states of the tide a 6,000-ton ship cannot get into Tilbury docks. The warehouses, railways and loading and unloading facilities are also very inadequate. The "Mail" does not say just what is to be done; but it approves of the thorough rectification of the channel and the building of new docks, warehouses, railways, etc., and the filling up of old docks now useless.

THE SUBMARINE TORPEDO-BOAT "FULTON" was launched on June 12 from the yard of Lewis Nixon, at Elizabethport, N. J. This is the first of the submarine boats of the Holland type ordered by the government, and she is built as a test-ship for the type. The "Fulton" is 63 ft. 4 ins. long, 11 ft. 9 ins. diameter, and has a 32-in. conning tower, 2 ft. high. The total weight of the boat is 103 tons, with 120 tons displacement when submerged. The motor is a 150-HP. gasoline engine, to be used when running on the surface and for charging the electric and compressed air accumulators. For submarine propulsion a 70-HP. electric motor will be employed. The estimated speed on the surface is 10 knots, and 7.5 knots submerged. The radius of action is 400 miles in ordinary cases, and 50 miles totally submerged. She will carry five torpedoes, instead of three as in the original "Holland."

THE GREAT NORTHERN STEAMSHIP CO., belonging to the Great Northern Railway, is building two steamships for the Eastern trade at New London, Conn., which are to cost $2,500,000 each. They are primarily cargo-carriers, and will be 630 ft. long, 73 ft. beam and 56 ft. deep. Five continuous decks extend the whole length, with three partial decks amidships. They will be fitted with the latest appliances for handling cargo; and the holds have a cubical capacity sufficient to stow 28,000 tons of coal, and the deadweight carrying capacity at normal draft is 20,000 tons. They will carry 150 first-class passengers amidships, 100 second-class, 150 third-class and 1,000 steerage passengers. The propelling machinery consists of two sets of vertical, direct-acting, triple-expansion engines, with 29, 51 and 89-in. cylinders and 57-in. stroke. The propellers are 20 ft. diameter, and at 90 revolutions per minute are supposed to drive the ship at 14 knots speed. There are 16 Niclausse water-tube boilers, with a total grate surface of over 1,000 sq. ft., and heating surface of 40,000 sq. ft. The total power is 10,000 I. HP.; in addition to an unusually large electric plant of 700 HP. and other auxiliary motors amounting in all to 1,800 HP. These ships are unusually strong and heavy in their build, the frames alone being 30 ins. apart and 12 ins. wide, and the average size of plate is 25 × 6 ft. and weighs 2½ tons. Some parts of the upper works are 3 ins. thick in solid metal.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Philadelphia & Reading Ry. at Paxtang, Pa., on June 15. An extra freight train collided with some runaway cars, wrecking the engine and cars and killing one man.

THE FERRY BOATS "Mauch Chunk," of the Central R. R. of New Jersey, and "Northfield," of the Staten Island Rapid Transit Co., collided on June 14 near their slips at the Battery, in New York city. The "Northfield," which was crowded with about 1,000 passengers, sank in about 15 minutes after the collision, but not until it had by its own power almost reached a nearby pier. Many tugs and other small craft came to the rescue of the passengers, many of whom had leaped or had been thrown into the water. Four or five persons are reported missing, but so far only two bodies have been found. The responsibility for the accident has not yet been fixed.

THE UNITED STATES TRANSPORT "Ingalls" was wrecked while being repaired in a sectional floating dry-dock at the Erie Basin, in Brooklyn, on June 14. Men were employed in shifting the ballast of pig-iron when the ship suddenly listed and the starboard shorers gave way. The dock was wrecked and sank with the ship. One man was killed and many were injured, and the boat was considerably damaged.

A BOILER EXPLOSION is graphically described in the Philadelphia "Evening Telegraph" of June 15. The engineer of a cooper shop at 30th and Market St. on the morning of that day started the fires under the boilers and "set about examining the water gage on the engine," when suddenly "the fire-gate on the big boiler flew open and an explosion occurred." The explosion wrecked the boiler and "the contents of the steam-chest enveloped the engineer's head and the upper portion of his body," but there are hopes of his recovery. The best theory of the accident, according to the "Telegraph," is that "the excessive dampness in the air this morning affected the draft in the boiler and in consequence the fire flowed back, causing the steam tank to explode."

THE SUPPRESSION OF FACTORY SMOKE is being investigated by the Mutual Boiler Insurance Co., of Boston, and the first report has been submitted by Mr. Edward Atkinson, President of the company. In summing up the replies so far received, he finds as follows: In works under effective management the quantity of coal consumed per horse-power hour ranges from 1.25 to 5 lbs. of bituminous coal. The quantity of water evaporated per pound of coal ranges from 6½ to 11 lbs. Complete combustion, free of smoke, except for a few minutes after charging, has been attained by skilled hand-firing; but Mr. Atkinson says that such skilled hands are rare, and soon find something better to do. Mechanical stoking is a surer method of preventing smoke; it works a large saving in coal, and yields more uniform results in making steam. Coal burned ignorantly with insufficient air develops carbon monoxide, and yields less than two-thirds the amount of heat produced by the same coal burned intelligently. Fuller reports will be submitted when more details are received from a greater number of works.

BIDS FOR GARBAGE DISPOSAL at New York will be received on June 27 by Mr. P. E. Nagle, Commissioner of Street Cleaning. Only the boroughs of Manhattan and the Bronx are included in the call for bids, and the bulk of the work will pertain to the latter borough. The estimated amount of garbage from Manhattan is 450 tons per day. The contract will run for five years from Aug. 1, 1901, and will include the reception of the material at the city dumps, on the river fronts, its removal from there and its final disposal. The contract is now held by the New York Sanitary Utilization Co., which has reduction works at Barren Island. These works were described in our issue of Feb. 1, 1900.

PRELIMINARY STUDIES OF THE PASSAIC VALLEY sewage disposal problem are to be made by local engineers, employed by the State Sewerage Commission. The engineers reported as having been engaged are as follows: Mr. Wm. Ferguson, ex-City Engineer of Paterson; Colin R. Wise, City Engineer of Passaic; Robert M. Watson, Borough Engineer of Rutherford; Ernest Adam, Engineer Department Streets and Sewers, Newark, N. J. It is understood that the work of these engineers will be largely local and independent, each of the other, in character but that they will confer together to a greater or less extent. It is also stated that their several reports will be submitted to other engineers for final consideration.

FOURTEEN STREET RAILWAY FRANCHISES in Philadelphia, almost unlimited in scope, have just been rushed through the city council and signed by the Mayor. This action was preceded by like headlong legislation at the State Capitol, which appears to have removed all restrictions on street railway franchises throughout the commonwealth. It is said that immediately preceding the date on which the new corporation law was to go into effect the railways centering in Harrisburg, and the hotels in that city, were crowded by would-be incorporators desirous of securing the two years of protection from all rival companies conferred by the new law on the first company to claim any given route. The Philadelphia franchises permit the construction of elevated, surface or underground street railways, and perhaps a combination of the three. They were granted to what are termed the Foerderer-March street railway companies, with which Mr. Robt. H. Foerderer is connected. A franchise application from Albert L. Johnson, in behalf of the Philadelphia & Lehigh Traction Co., offering 3-ct. fares and free transfers, was pigeon-holed by the city council. An offer from Mr. John Wanamaker to give $2,500,000 for the 14 franchises so hastily passed, received no more attention. There is talk of testing the validity of the franchises in the courts.

THE LONG ISLAND EXTENSION RAILROAD CO. was incorporated at Albany on June 18 with $1,000,000 capital. This company is to build and operate by electricity or other suitable power a tunnel about four miles long connecting the Long Island Railroad property in Long Island City and a point in Manhattan Borough "south of 50th St. and west of Broadway." This tunnel would pass under the East River, and the city terminal referred to is possibly the Manhattan end of the proposed North River bridge. The tunnel company evidently has the backing of the Pennsylvania R. R. Co., as Mr. Samuel Rea, Vice-President of the Pennsylvania R. R. Co., is President of the tunnel company, and Mr. Wm. H. Baldwin, President of the Long Island R. R. Co., is one of the directors.

THE NEW U. S. MINT at Philadelphia was completed in April of this year, and was accepted by the government on June 13. Work on the building was commenced in April, 1898, and the general dimensions are: 318 ft. long by 208 ft. wide. The cost was something over $2,000,000. The silver dollar vaults in the basement will hold $100,000,000, and $70,000,000 are stored there now.

NEW PASSENGER, DINING AND OBSERVATION CARS.

A number of railways are now adding to their passenger equipment cars specially built for service on the fast and long-distance trains, on which special attention is given to the comfort and convenience of the passengers. While no great novelties in structural design appear to be introduced, and while matters of interior finish (which

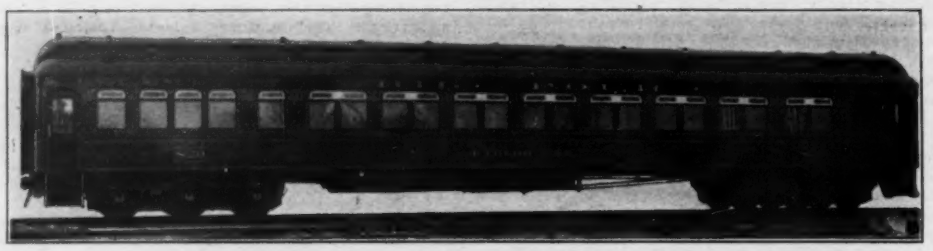

FIG. 1. PARLOR CAR FOR THE CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS RY.
Barney & Smith Car Co., Dayton, O., Builders.

are the most conspicuous features of many of the cars) are not of general interest to our readers, yet some of them are of interest on account of their size or certain features of their design, and examples of a few cars of the above class are illustrated herewith.

DAY CARS AND PARLOR CARS; C., C., C. & ST. L. RY.—To provide new equipment for the fast through train service between St. Louis and Buffalo, and Cincinnati and Buffalo, and also for the day trains between Chicago and Cincinnati, and St. Louis and Cincinnati, this road has had sufficient cars built to make up ten complete trains. One train of the new cars, consisting of a combination baggage and smoking car, three coaches and a parlor car, has recently been sent over the entire system for exhibition at the principal cities. A special feature of the cars is their great length and unusually large seating capacity, so that it is estimated that none of the through trains will require more than one combination car, two coaches, one or two parlor cars, a dining car and the usual through sleeping cars.

The day cars or coaches are 70 ft. long over the end sills and 77 ft. 6 ins. over the vestibules, or 78 ft. 8 ins. over all. The width is 9 ft. 10½ ins. over the sills, the cars being 1 ft. wider than the ordinary coaches, and set higher, so as to require an additional step to the platform. Lavatories as well as closets are provided for both sexes. This is a very commendable practice, and adds much to the comfort of the passengers on long through runs. In the body of the car there are no less than 21 pairs of seats, with extra seats at one corner, so that the car has seating capacity for 87 passengers. The windows are 28 ins. wide in the clear, with glass 24 × 25 ins. The cars have the Buhoup wide vestibules, and all the ventilators are protected by dust and cinder-proof screens. They are lighted with compressed gas on the Pintsch system, having seven lamps inside and one over each platform. They are h ated by steam, the temperature being regulated by a thermostat in each car. The cars are mounted on six-wheel trucks and weigh 50 tons, or about 1,287 lbs. per passenger.

The combination cars are very similar to the above, but have no platform on the baggage end. The baggage room is 31 ft. long, with a door in each end and two side doors 4 ft. 2 ins. wide. The part occupied by passengers is 38 ft. 6 ins. long, and has 12 pairs of seats, with an extra seat opposite the toilet room, giving seating capacity for 50 passengers.

The parlor cars are the same length as the coaches, but 10 ft. wide over the sills. At one end are the smoking room, buffet and men's toilet room, while at the opposite end are a stateroom and the women's toilet room. A writing table is fitted in one corner. There are 22 revolving chairs, and the total number of passengers accommodated is 37. The car is lighted by 13 Pintsch lamps, of which six are in the main saloon and two over the platforms. The weight is 53 tons, or about 3,209 lbs. per passenger.

The interior finish is very handsome, polished wood and inlaid work being largely used, while different colors are used for the upholstering and painting in the different cars. The exterior design of all the cars is alike. They are very striking in appearance, being painted a bright orange color with a crimson letter board, and all lettering and decoration in gold leaf. The vestibule doors are of polished mahogany. Fig. 1 is an exterior view of one of the parlor cars, and Fig. 2 is an interior view. All these cars have been built by the Barney & Smith Car Co., of Dayton, O. For information and photographs we are indebted both to the builders and to Mr. W. J. Lynch, General Passenger Agent of the C., C., C. & St. L. Ry.

DINING CARS; C., B. & Q. R. R.—As recently noted in our columns, the Chicago, Burlington & Quincy R. R. has added to its equipment several large and elaborate dining cars, one of which is shown in Fig. 3. These cars are 70 ft. long over the sills, 78 ft. over the platform, 10 ft. 4 ins. wide over the sills, 9 ft. 5 ins. high from floor to ceiling, and 14 ft. from the rail to the top of the roof. The car will seat 30 persons at the ten tables, the tables on one side being for two persons, and those on the other side for only one person. The weight is 120,000 lbs.; or 4,000 lbs per passenger.

The dining room is 32 ft. 2 ins. long, and the tables are spaced 6 ft. 4 ins. c. to c. and are 2 ft. 8 ins. wide. There are five Pintsch gas lamps in this room, and an electric fan at each end. At one end of the car is the buffet, with a wine locker and Bohn refrigerator, the ice for which (as well as for all the other refrigerators) is put in from the top of the car. The heater, linen locker, etc., are also at this end of the car. At the other end are the kitchen and pantry, with cooking range, provision chests, refrigerators, etc. A partition across the platform screens the kitchen from the view of passengers entering the car at this end. The cars are equipped with the Gold car-heating system and lighted by acetylene gas on the ams & Westlake system. The interior finis of black Flemish oak, with the ceiling in ye and the upholstering in dark red. The exte ap- pearance is of the latest pattern, and it be noted that there is no belt rail or moldin the level of the window sills, the vertical sh ing extending from top to bottom. This is a recent innovation in exterior treatment. T ars are mounted on six-wheel trucks. These ca ers built by the Pullman Co., of Chicago, a for plans and other information we are inde to that company, as well as to Mr. P. S. lis, General Passenger Agent of the C., B. & Q R.

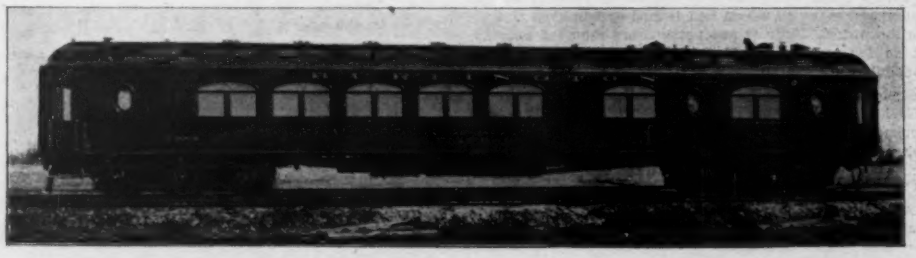

FIG. 3. DINING CAR; CHICAGO, BURLINGTON & QUINCY R. R.
Pullman Car Co., Chicago, Builders.

OBSERVATION CAR; NORTHERN PA FIC RY.—The car shown in Figs. 4 and 5 is an ser- vation and pleasure car for very long run and equipped with a variety of conveniences. It one of the cars specially built for the Northern P ific Ry. for use on the "North Coast Limited" ains, running between St. Paul and Portland, 2,056 miles. At the rear is an observation platform, partly sheltered at the sides, the end of the car body being set back, as shown. In the hood over this platform is formed an ornamental dome. The observation room, opening upon the platform, is 16 ft. 3 ins. long, and fitted with 14 movable chairs. The side windows of this room are 3 ft. wide, and the end windows reach rearly to the floor. Beyond this are four fixed seats, a writing desk and bookcases. A corridor runs thence along one side of the car, and from this open the women's toilet room, barber shop, bath room, buffet, and two smoking rooms, each of the latter having six chairs and a folding table. The men's toilet room and the heater occupy opposite corners of the end of the car.

Fig. 2. Interior of Parlor Car; C., C., C. & St. L. Ry.

These cars are 70 ft. long over the sills, 78 ft. over the platforms, and 10 ft. wide. They are mounted on six-wheel trucks. For plans, information etc., we are indebted to the builders, the Barney & Smith Car Co., of Dayton, O., and also to Mr. Alfred Lovell, Superintendent of Motive Power of the Northern Pacific Ry.

DAY CARS; INTERCOLONIAL RY.—Among the numerous passenger cars now under construction by the Barney & Smith Car Co., are several for the Intercolonial Ry., of Canada. The special feature of these cars is that the exterior sheathing is of narrow vertical strips of varnished mahogany. When new this is of a very light tint but it soon darkens with exposure. The appearance, however, is quite different from that of the Canadian Pacific Ry. cars, which have an exterior finish of redwood. Mr. G. R. Joughins, Mechanical Superintendent of the Intercolonial Ry., informs us that the varnishing of the natural wood is found very satisfactory, and is more economical than painting, if care is taken to use the very best varnish.

SPECIFICATIONS FOR FIRE PUMPS.

At the annual meeting of the National Fire Protective Association, three committee reports on fire pumps were presented. The one on "Electric Fire Pumps" was supplementary to a report made at the previous annual meeting; this was presented by Mr. C. M. Goddard, of Boston. The others on "Steam Fire Pumps" and "Rotary Fire Pumps" were presented by Mr. W. H. Stratton, of Hartford, Conn. Abstracts of the three reports are given below.

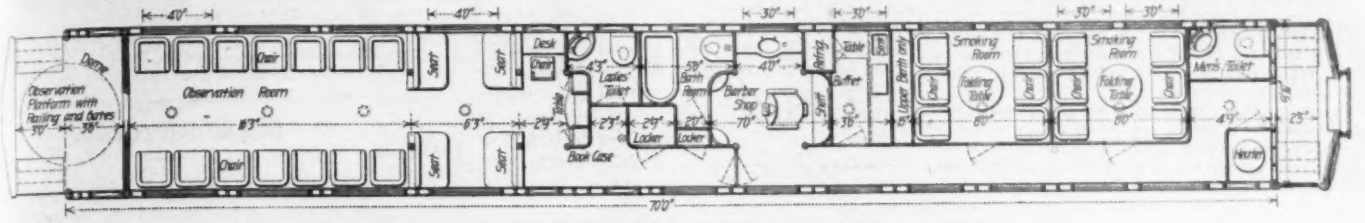

FIG. 4. FLOOR PLAN OF OBSERVATON CAR; NORTHERN PACIFIC RY.

Barney & Smith Car Co., Dayton, O.; Builders.

ELECTRIC FIRE PUMPS.

Last year your committee on electric fire pumps prefaced its report with the following statement:

It should be readily understood that the recommendations and suggestions which your committee shall make, must of necessity be largely those which are founded on theory rather than practice, as the actual experience with electric fire pumps is extremely limited.

After the lapse of a year your committee does not find that the actual experience with electric fire pumps has been increased to any material extent. It therefor, submits only th following additions:

PROTECTION OF DEVICES.—The starting apparatus circuit breaker and all the necessary electrical devices must be so enclosed as to be thoroughly protected from injury by moisture or otherwise. The motor must be thoroughly ventilated.

STARTING DEVICES.—When circumstances render it advisable to install an electric fire pump that shall be automatic in its action, we would, for the present, recommend that a small air-pressure tank be connected with the system between the electric pump and the check valve against the second supply. The pressure in this tank to be maintained by a small pump, either automatic or not, in a manner similar to that which would be employed to maintain the air pressure in a dry system. The main pump to have an automatic starting device which would only operate when the pressure in the air tank fell to 66⅔% of the normal. The pump to then start at full speed and so continue until shut down either by hand or by the automatic device. This device, however, need not be so arranged as to stop the pump automatically; if it is so arranged, it should not act until the normal pressure has been reached. In all cases where an automatic starting device is used an independent hand-starting device should also be provided.

Other things being equal, preference should always be given to a pump having the least number of reductions of speed.

Under the head of motors in our original report, the sentence reading "The capacity of the motor should be probably at least 25% larger than necessary to run the pump at full output," should be amended to read as follows: "The capacity of the motor should be probably at least 25% larger than necessary to run the pump at full output, and must be capable of sustaining the full output capacity of the pump, at full speed, and at a water pressure of 100 lbs. per sq. in. for 10 consecutive hours, without any excessive rise in temperature in any part of the apparatus, and without any undue depreciation in the insulation."

ROTARY FIRE PUMPS.

The best designs and products now available are perhaps as good as your committee could expect, but it is the unfortunate surroundings that make this kind of pump so questionable.

The location of these pumps is usually in a wheel-pit in an out-of-the-way place, subject to many variations of conditions, alternating dry and wet, hot and cold where all parts rapidly accumulate rust. The operation involves the most dangerous conditions. Starting a rusty device, all cast iron, perhaps in a temperature below freezing, after long disuse, putting it immediately under high velocity and excessive journal pressure, invites a disaster. We rarely find them properly supplied with the right kind and quantity of lubricant, and we feel it only necessary to report that just as few of these pumps as possible should be used, that they should be located to the best advantage as suggested by the underwriters where they have the opportunity, and that they should be provided with all the safeguards known to be needed, namely:

1. A barrel of well-chosen lubricant.
2. A check valve to guard against the loss of water from other sources should the pump go to pieces.
3. A pop or spring relief valve to avoid dangerous pressure.
4. Securely set upon reliable foundations to prevent vibration or strain, preferably to be driven by separate wheel.
5. If geared to the general power, all other machinery should be arranged to throw out by friction clutch at or near the pump.
6. Friction gears, or (if possible to find) a reliable clutch, should be the means of attaching power to the pump; both the pump and the gearing to be so securely fastened that they cannot shift when the gears or clutch are thrown in.

STEAM FIRE PUMPS.

At the last meeting, your committee reported that the specifications then in force concerning the construction of the Underwriters' pump were found acceptable, and at that time we had no recommendations to make for correction. Our views are changed at this time, however, to the extent of making some suggestions in the specifications and urging a program under which the laboratory officials shall be able to obtain strict adherence to the requirements as presented.

It is proper that we should make acknoledgment to Mr. John R. Freeman (M.Am.Soc.C.E.), who compiled the original requirements for the Underwriter pump. The chairman of this committee has conferred with him and obtained permission to use any or all of the existing standards, and also believes that the corrections and requirements which we are about to submit will meet with his approval and adoption. The Freeman specifications have been in force since 1895, although the preliminary work and development covered a period of five years prior to that date, and as the specifications will be printed in full in connection with this report, the existing conditions and the objections to certain items and the proposition for their correction will all be embodied in the records of this year's convention.

The fire pump is the main reliance and safeguard against fire involving immense money values. Therefore, it is necessary that we should carefully prepare specifications and plan to see that they are strictly adhered to, and further, to include in our requirements the proper means for its safe location, correct pipe connections, provision for the proper auxiliary apparatus and to guard it against accodent from falling buildings, freezing and all other means of disqualification.

1. While it is specified in the requirements that "on the pump-maker rests the responsibility for first-class workmanship, good material and proper strength," and with due allowance for the uncertainty concerning the results of iron castings and the possibility for hidden defects, despite the best efforts, your committee feels that makers should be called upon to guarantee that after their best efforts are carried out they will still replace promptly and without cost any defective parts, more especially the iron castings. The inspectors of the department in charge of your chairman have found a number of accidents resulting in breaking of various parts of fire pumps and have sent pieces to the office which show that the castings were defective. It would appear that the makers' interest would prompt them to avoid spending the time and money involved in putting the pump together having a defective cast-iron part, as the value of iron would be insignificant compared with the labor involved. This is a feature of administration that can be best adjusted by whatever authority has in charge putting into execution any standard that we may adopt, making necessary arrangements with the manufacturers, but we can show samples and quote cases indicating that much improvement on the part of the makers is needed in the main castings for the pump.

2. Time has developed the fact, and we have the parts here to show, that the water valves of the pump require considerable improvement to prevent their giving out, disqualifying the pump and the parts going into the fire protection system and perhaps stopping up the sprinkler mains. We recommend that the base of the valve be screwed into the valve deck, as involving the safest conditions so far brought to our notice. One valve, which we exhibit, seems to show that it was probably loosened by vibration and washed away and found in a hydrant, not being screwed into the valve deck but fastened by a tapering wedge joint. We have, however, Mr. Freeman's statement that valves screwed in have worked out by vibration. Therefore, your committee would suggest that the base should be screwed into the valve deck and then fastened to prevent turning by vibration.

3. The next feature that has developed a weakness is the screw where the stud that holds the spring is fastened to the center of the valve base. This attachment is sometimes liberated and has worked out, probably by vibration, allowing the valve stud and spring to be washed into the fire mains, and being found in a hydrant. It is most fortunate that these parts did not enter and fill a pipe leading to sprinklers. As this can be more readily adjusted than the fastening of the valve itself into the deck, it is suggested that it be screwed through the base and one of the many known mechanical means of preventing the turning of the stud resorted to, preferably such a plan as will permit the taking out of the stud while in the valve deck in order to replace the rubber valve, which is often necessary.

4. The next feature is the rubber valve itself, and we have samples to show the effect of pressure holding a poor composition so tightly upon the valve base that the imprint of the web and frame is shown bedded deep into the face of the valve, which, of course, will ruin the tightness of the valve. The quality of rubber should be definitely stated and means taken to positively obtain adherence to the requirements.

5. The next item is the plate upon the top of the rubber valve which prevents the spring bearing upon the rubber, and also by the annular bead or ring holds the spring in proper adjustment and prevents it from getting out of po-

FIG. 5. OBSERVATION CAR OF "NORTH COAST LIMITED;" NORTHERN PACIFIC RY.

sition. The lack of this plate permits the spring to work to one side, then buckle and tangle the spirals, throwing out of adjustment the relations of the valve to the duty required, for it makes a great difference in the operation of the pump; in one way cutting down the capacity, and in another making the pump slam unless these springs are in correct position and adjustment.

We have two samples of new valves. The one apparently in full conformity with the standard lacks the plate just described, although the number of webs is four instead of six, which means the giving out of the rubber valve disks more rapidly The other sample has the proper number of webs and the plate upon which the spring rests, but is made to be fitted into the valve deck on a smooth taper. No doubt there are many pumps to-day disqualified wholly or in part in this way, and we may expect to find after the loss of a property that such valves have been forced into the mains and obstructed the flow of water to the fire apparatus.

6. In regard to the priming pipes, we exhibit one of the special check-valves showing the result of its operation under high pressure, which indicates that they have not been made heavy enough and that the lift of the valve has been too great. A revision of the requirements should involve making this valve of proper strength and adjusting the lift from the seat to a minimum. This, we understand, the makers have under consideration, but if they are brought within the guarantee it will prevent putting out parts that will be necessary to replace at their expense.

7. In the Freeman specifications, the outlet from the discharge of the pump is illustrated showing the air chamber directly on top and the hose valves connected on the side of the elbow. The intention of the designer in this arrangement was to make the pump available as an individual apparatus, so that everything could be shut off by one gate valve and hose streams, attached directly upon the pump and its full capacity obtained in that way. Unfortunately, however, the usual location of fire pumps makes the valves thus attached inaccessible or dangerous to use. It is usually necessary to make a short bend in all or part of the hose streams leading from the pump. Such a strain immediately at the pump, where the full shock of the valve pulsations are delivered, is liable to burst or blow the hose off the coupling. This has happened many times. Your committee therefore recommends that the valves shall not be attached in this way, but that a spool casting having flanges in three directions shall take the place of the present arrangement, so that all the outlets of the pump may be extended in the direction available and through the wall of the pump house, where the possibilities of blowing off the hose will be reduced, short bends in hose avoided and the washing of the attendant out of the pump house averted.

By our committee's suggestion the hose will be removed from the effect of the heat in the pump house, not only made more valuable, but its life prolonged, resulting in a saving to the mill owner and better protection to the insurance companies.

8. In the specifications, a sight-feed lubricator is shown connected into the steam yoke. No doubt such an arrangement will, for the quantity of oil it holds and the few drops per minute which it will feed into the steam cylinders, be a reasonable means of lubricating the pump for a short service provided the pump is in excellent condition. Unfortunately, experience shows that fire pumps are greatly neglected, and that they are set in places alternately damp and dry, hot and cold. The steam cylinders rust in damp and cold weather, and a hardened deposit accumulates from the oil that remains in them. Your committee would suggest a sight-feed lubricator of appropriate capacity and in addition, and as a main reliance, a hand oil pump of at least a pint capacity, so that when the pump is called into full capacity after long disuse it may be given a large quantity of oil to start it and overcome all of the disqualifications that may exist. Furthermore, a high-grade steam engine lubricant should be kept in a metal can (of say five gallons capacity) in the pump house, always at hand to recharge the hand oil pump and maintain a big fire pump in easy working condition for a long period in a bad fire.

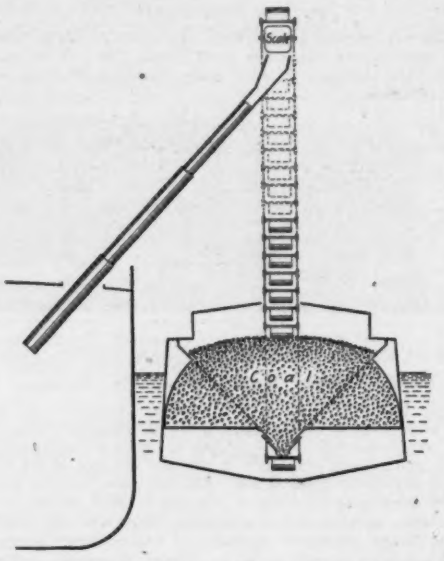

Diagram Showing Method of Operation of the Coaling Barge.

Another objection to the old method has developed in actual experience. It has been found that the pump is often permitted to take the place of a hydrant, and this requires that the equipment of fire hose shall be kept in the pump house. We have an illustration of recent date where the highest type of fire hose was disqualified by heat acting upon the rubber within three or four months.

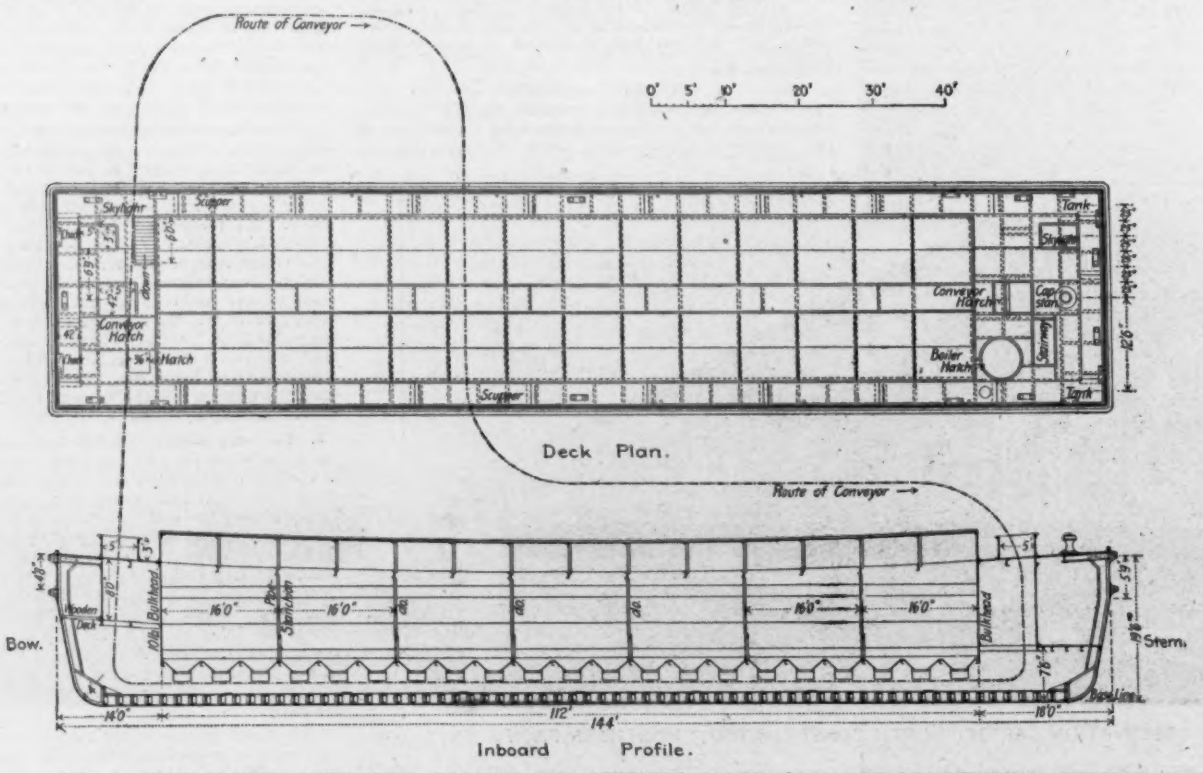

FIG. 1. THE CLARKE AUTOMATIC COALING AND WEIGHING BARGE. PLAN AND LONGITUDINAL SECTION.

As stated in the opening of this report, the efforts tending toward the correction of a stan... commenced in 1890, and the specifications now were issued in May, 1895. During the five years... the issue of 1895, the designer was in constant ... with makers and for various reasons it is needful... they became thoroughly familiar with the conditions involved in the specifications, which for a time ... the excellence of their products. At this time ... we do not feel that it is safe to recommend the ... of an Underwriter pump without a special contract ... ing the complete specifications with an agreement ... part of the maker to comply thereto with appropriate ... serious penalty attached. Until such an arrangement ... be put into effect, such as the Underwriter's laboratory now uses with other apparatus, we must rely ... the manufacturers of these pumps, although the present condition of their products does not warrant us in so doing.

BOOK REVIEWS.

CONGRES INTERNATIONAL DE SURVEILLANCE ET DE SECURITE EN MATIERE D'APPAREILS A VAPEUR, TENU A PARIS EN 1900. Secretaire General M. Compère. Paris: E. Caplomont et Cie, 57 Rue de Seine. Paper; 6½ × 10 ins.; pp. 512.

This record of the 24th Congress of the owners of steam plants contains a number of papers upon the maintenance and security of steam generating apparatus; including the inspection of boilers of various types and under the laws of various countries; the tests of boilers; accidents to boilers; the purification of feed water; the interior corrosion of boilers; their manufacture, etc. These papers are written by men of experience and acknowledged as authorities in Europe.

A second volume, issued along with this, gives an account of the 23d Congress of the same association, held in Paris in 1899.

ELECTRIC LIGHTING.—Vol. II., Distributing System and Lamps. By Francis B. Crocker, Ph.D., Professor of Electrical Engineering in Columbia University. New York: D. Van Nostrand Co. Cloth; 6½ × 9 ins.; pp. 501; 391 illustrations. $3.

The first volume of this work was devoted to a description of the machinery and appliances found in the generating plant of an electric lighting system. The present volume relates to the conductors for transmitting and distributing the current and to the various auxiliary devices, such as switches, cut-outs, meters, etc., employed in connection with the same. It is designed to be a text-book for students and a hand-book for practicing engineers, and, hence, contains little that is either abstruse or detailed. It does contain, however, a plain, logical and clear description and discussion of the methods and materials now in use for the distribution and utilization of electric energy for lighting. Furthermore, the book is filled with useful and well-executed illustrations and is excellently printed. The author gives numerous references to contemporary technical literature. The scope of the work is indicated by the titles of the chapters, some of which are as follows: Electrical Distribution; Physical Properties of

...ers; Parallel Systems of Electrical Distribution; ...s of Electrical Conductors; Principles of Alternat... ...rrents; Alternating Current Systems of Distribu... ...Underground Electrical Conductors; Arc Lamps; In... ...ent Lamps; Lamps not Employing Carbon. In ap... ...s are given the National Electric Code and the ... ...of the Committee on Standardization of the Ameri... ...stitute of Electrical Engineers.

THE ZIEGLER-BALDWIN ARCTIC EXPLORING PARTY is to sail from Tromsoe, Norway, on June 25. There will be three ships in the outfit; the whaler "America," a three-masted sailing ship of wonderful strength, fitted with an auxiliary steam plant and a single screw, will carry Mr. Baldwin and his party; the "Fridtjof," a Norwegian sealer, will carry stores and provisions as far north as Franz Josef Land, and the third ship, the "Beljica," will carry Capt. de Gerlache and his party to the Arctic Ocean and land supplies on the east coast of Greenland.

THE CLARKE AUTOMATIC COALING AND WEIGHING BARGE.

We illustrate herewith a new method of coaling steamships which has been in successful operation for the past year in New York harbor by the Automatic Coaling and Weighing Barge Co., 71 Broadway, New York city, to whom we are indebted for the accompanying illustrations, and for the opportunity of making an inspection of the barge while in operation.

The automatic barge is designed to effect a revolution in the old-fashioned method of coaling steamers, which consists in shoveling into buckets the coal contained in a barge lying alongside, elevating these buckets by means of one of the steamer's winches, and dumping them into the bunkers where the coal is stowed by trimmers.

By the new method the coal in contained in a steel barge of 1,000 gross tons capacity, divided by transverse bulkheads into several compartments or coal bins. The floor of each bin is raised above the bottom of the barge, to accommodate a passageway which runs the whole length of the bins, just above the keel, and in which a train of buckets is drawn by an endless chain composed of flat steel links. There are three square openings in the bottom of each bin, closed by sliding doors, and as each hole is opened, the coal, lying above it, slides down into the buckets. The train of buckets is moved by means of a steam engine in the rear compartment of the barge, through the horizontal passageway, then vertically upwards in a tower, then again horizontally to a scale house at the top of the tower, which contains two automatic weighing and recording scales, into one of which each alternate bucket is dumped. The coal then slides from the scales into two telescopic steel tubes, which deliver it into the bunkers of the steamer. The principle of the coaling barge is therefore similar to that of the well-known floating grain elevator, but the machinery is much heavier, and contains many devices to facilitate the handling of a somewhat intractable material like coal.

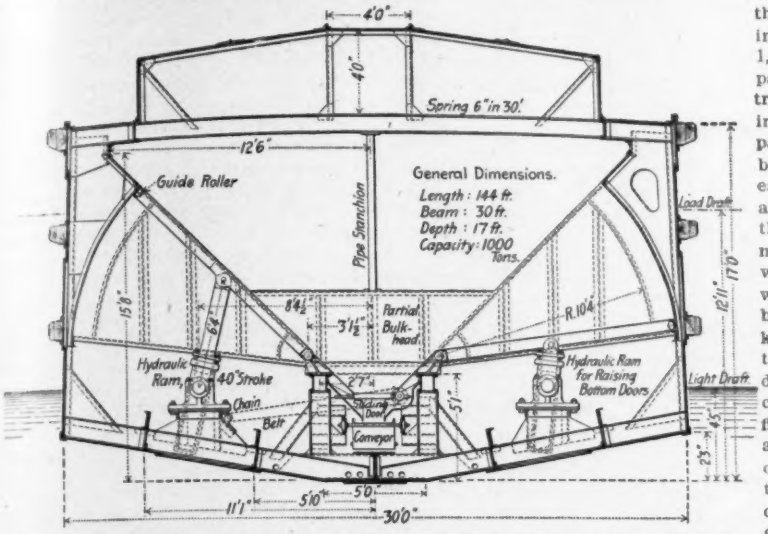

FIG. 2. TRANSVERSE SECTION OF CLARKE AUTOMATIC COALING BARGE.

The barge delivers the coal steadily at the rate of 125 gross tons per hour, and has been operated for several hours at a time at a rate of 135 tons. The whole operation is almost noiseless and free from dust, and it is accomplished entirely by the machinery of the barge, without any hand labor, and without the assistance of any of the machinery or crew of the steamer.

Referring to the illustrations: Fig. 1 is a longitudinal vertical section and plan of the barge. Its dimensions are: length, 144 ft.; beam 30 ft.; depth 18 ft. from deck to keel; draft, loaded, 14 ft.

The rear compartment contains the boiler, engine, hydraulic pump, gearing and other appurtenances of a complete power plant. The forward compartment contains the quarters for the crew. The other compartments are all devoted to coal bins. Each bin is 16 ft. long (in the direction of the length of the barge) and 28 ft. wide at its greatest horizontal section, and each discharges its coal into three openings 22 inches long by 24 inches wide at its bottom.

Fig. 2 shows a transverse vertical section of the barge, taken through one of the coal bins, and this view shows several of the most important elements of the barge's mechanism. First of these is the elevating floor, which is shown in its lowest position at the right hand of Fig.2, and in its highest position at the left. Each of the movable floor sections is hinged at its lower edge, and at the outer edge almost touches the inner surface of the sides of the bin, which are formed in a curve, as is clearly shown in the drawing.

Each of these movable sections of the floor is 16 ft. long and 11 ins. wide, is strongly built, and therefore heavy, and supports a considerable load of coal. The lifting of each one is accomplished by means of two hydraulic lifting rams, each with a plunger 6 ins. diameter and 42 ins. stroke, which oscillate on trunnions. There being two lifting jacks to each movable section of the floor it is essential that each one of the pair moves in harmony with the other, so that neither one can get in advance of the other, although the loads upon the two may be very unequal. This is accomplished by means of an automatic two-way hydraulic valve, which governs the admission of water to both of the cylinders. As long as the outer edge of the moving floor section remains horizontal, while it is being lifted, the valve is in mid-position, delivering water equally to each of the two cylinders; but the instant that one end of the outer edge becomes tilted upward, the valve is moved so as to check or stop the water flowing into the cylinder nearest that end until the horizontal position of the outer edge is restored. This ingenious application of a single valve to control two or more hydraulic lifts connected to a single moving platform is adaptable to many other purposes besides the one for which it is used in this

FIG. 3. HYDRAULIC LIFTS UNDER THE FLOORS OF THE COAL BINS.

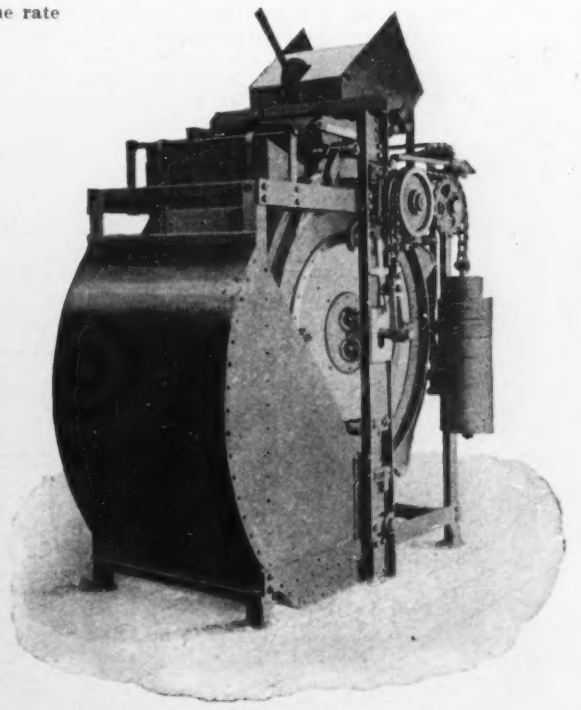

FIG. 7. THE CLARKE AUTOMATIC WEIGHING SCALE.

barge. It is the invention of Mr. P. B. Clarke and is fully protected by patents.

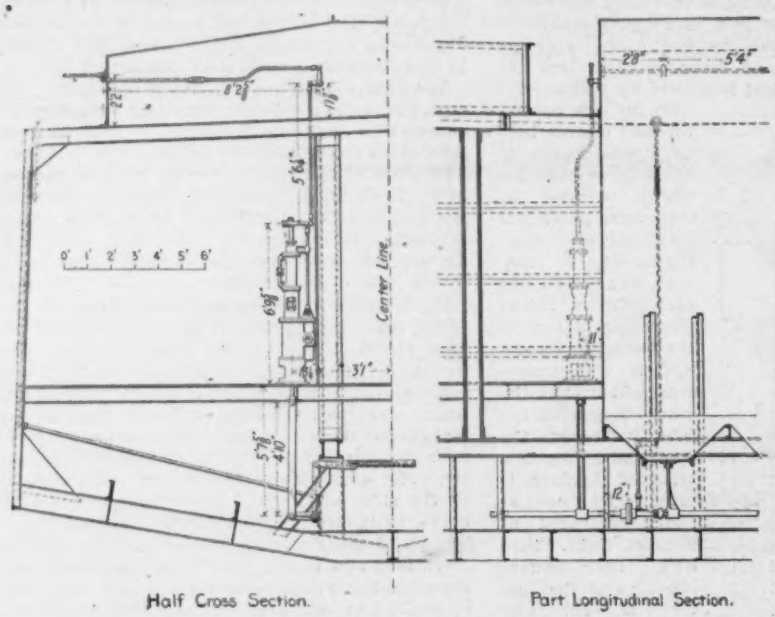

FIG. 4. STEAM CYLINDER AND CONNECTIONS FOR OPENING AND CLOSING SLIDING DOORS UNDER COAL BINS.

Fig. 3 is a photographic view of a row of the hydraulic lifts under the moving floors of several of the bins. All of the lifts are supplied with water under pressure from a hydraulic pump and accumulator located in the compartment at the rear of the barge. The valves controlling each pair of lifts are located near them, but the handles by which they are operated are located at a convenient position above them on the upper deck, a long rod connecting each valve with its handle.

The next features connected with the coal bin to be considered are the gates or doors which close the two rectangular openings in the bottom of each bin, and the method of operating them. They are simply flat cast-iron plates supported and operated on specially designed bearings by which the usual clogging of the coal is eliminated. They are opened and shut by a system of bell crank levers, shown in Fig. 4, which are operated through easily detachable jaw clutches, by means of a shaft which runs the whole length of the coal bins back to the stern compartment, where it is actuated by a steam cylinder. Handles located above each coal bin on the upper deck control the clutches belonging to the levers of each of the gates, and also the valves of the cylinder, to rotate the shaft and open or shut at will any one of the gates when its clutch has been thrown into action.

Still another mechanical feature connected with the coal bin is a rotating picker bar, shown just above the gate at the bottom of the bin, in Fig. 2. The coal in sliding down to the openings in the bottom of the bin often becomes blocked by wedging or scaffolding itself across the inclined surfaces of the lower part of the bin, but it is easily started sliding again if it is touched with a bar or pick. This is the office of the rotating picker. It is driven by chain gearing from a shaft which is carried from the coal bins back to the engine room; and is, at will, connected or disconnected from the shaft by a clutch operated from the deck.

Leaving now the coal bins we come to the passageway underneath them, which contains a railroad track and a continuous train of buckets, called gravity buckets, which are pivoted and swung from steel links on both sides. The links are carried on wheels which run on the rails. The buckets are shown in Fig. 5. The lip of each overlaps the edge of its neighbor so that no coal can drop between the buckets. As the buckets become loaded by passing under an opening in the bottom of one of the coal bins, they then pass under the edge of this opening, where the trimming above referred to takes off the surplus load and lets the buckets pass one after the other, each with a uniform level load.

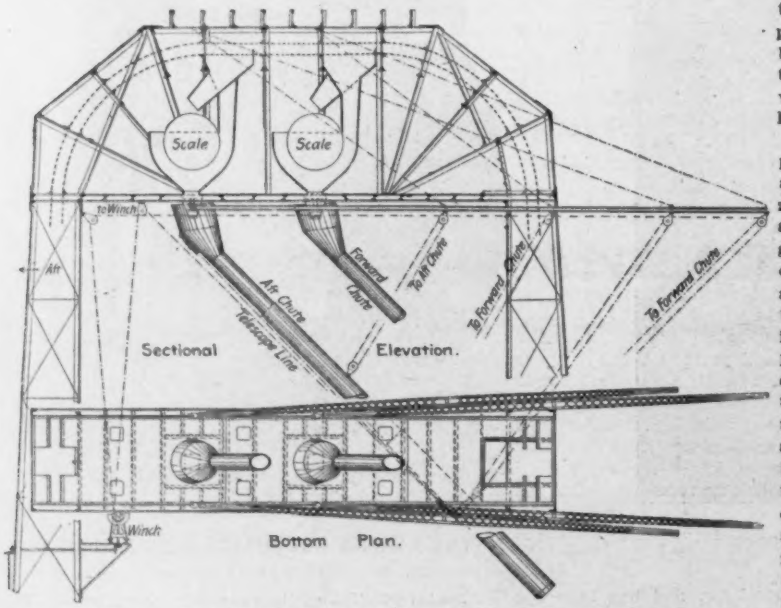

FIG. 6. ARRANGEMENT OF SCALES AND DELIVERY TUBES.

The buckets while pivoted in the links are kept in a horizontal position by an arrangement of guide rails. The train of buckets is moved along by means of the links to a point in the forward compartment, where its direction is changed to the vertical, by the links passing 90° around a wheel, and its motion then continues upward, guided by vertical tracks supported on the framework of a tower to the top of the latter, where the tracks bend to the horizontal. The buckets then travel horizontally a short distance, when the coal in each alternate bucket is dumped into a hopper leading to a weighing scale located just below. The second bucket of each pair is dumped when it reaches the hopper of a second scale a little further along. The arrangement is shown in Fig. 6. The empty buckets then descend the second tower to a point a few feet above the deck then travel to a point above the stern compartment into which they descend to the level of the passageway. In this compartment the links which carry the buckets, forming an endless chain, engage with a heavy sprocket wheel, which is driven by gearing from the engine.

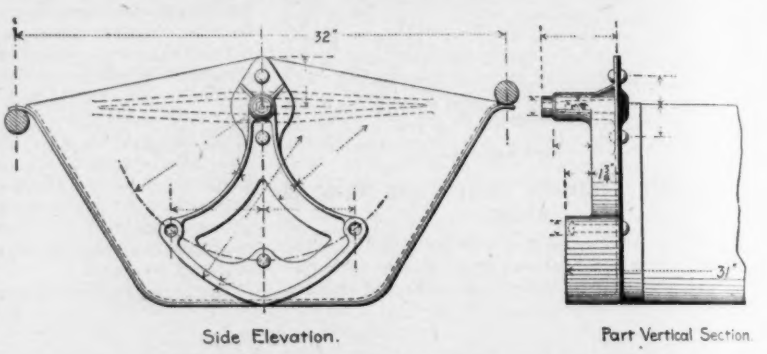

FIG. 5. ELEVATION AND SECTION OF COAL BUCKETS.

The work done by the engine, when the barge is delivering coal at the rate of 125 gross tons per hour, is that of elevating this coal from the level of the track in the bottom to the level of the track above the scales, a distance of 75 ft., or 125 × 2,240 × 75 = 21,000,000 ft. lbs. per hour, which is equivalent to 10.6 HP., besides the overcoming of the frictional resistance of the moving buckets, links, and gearing, which is about 1 HP. A trifling amount of power of the engine is also used in operating the horizontal shaft which actuates the rotating pickers in the bins. The boiler furnishes steam for the engine, for the steam cylinder used for moving the gate valves under the coal bins, and for the hydraulic pump which supplies water to the hydraulic cylinders under the movable floor sections.

The steam engine is an ordinary slide valve engine rated at 20 HP. Its speed when moving 125 tons of coal per hour averages 200 revolutions per minute, but it has been run as high as 250 revolutions.

The boiler is a vertical tubular, 58 ins. diameter, rated at 50 HP., and run at about 60 lbs. pressure.

The automatic scale, shown in Fig. 7, is a remarkably efficient piece of mechanism. It consists of a rotating cylinder divided by sheet steel partitions into four quadrantal sections or compartments, each capable of holding ¼ ton, or 560 lbs. of coal. In its normal position for receiving coal the partitions stand at an angle of 45° with the vertical, so that the opening of one of the compartments is directly upward. The whole weight of the cylinder, together with the coal that may be in one compartment, is carried on two journals, the boxes of which are movable vertically a distance of 3 ins., between guides, the bearing of the boxes on the vertical guides being a set of four wheels, to diminish friction. The weight on each of these boxes is supported by well-made and nearly frictionless chain, carried over two ball-bearing pulleys to a heavy counterweight, as shown in the cut. These ball bearing pulleys take the place of the knife edge pivots of ordinary scales. They are enclosed in dust-proof casings.

The angle of the hopper delivering coal to the scale is such that the coal slides down it at a moderate rate and the edge of the hopper is so close to the scale that when the compartment of the scale is full the coal is blocked in the hopper, and there is no coal falling through the air. The instant that there are 560 lbs. of coal in the scale the counterweight is overbalanced, and the scale begins to descend, a knife actuated by a heavy weight suddenly cuts off the descending stream of coal, a latch is thrown open, the scale rotates through an angle of 90° and dumps its coal into the hopper below, whence it slides through the telescopic tubes to the coal bunker in the steamer. The coal having fallen out of the scale, the counterweight brings the rotating cylinder back to

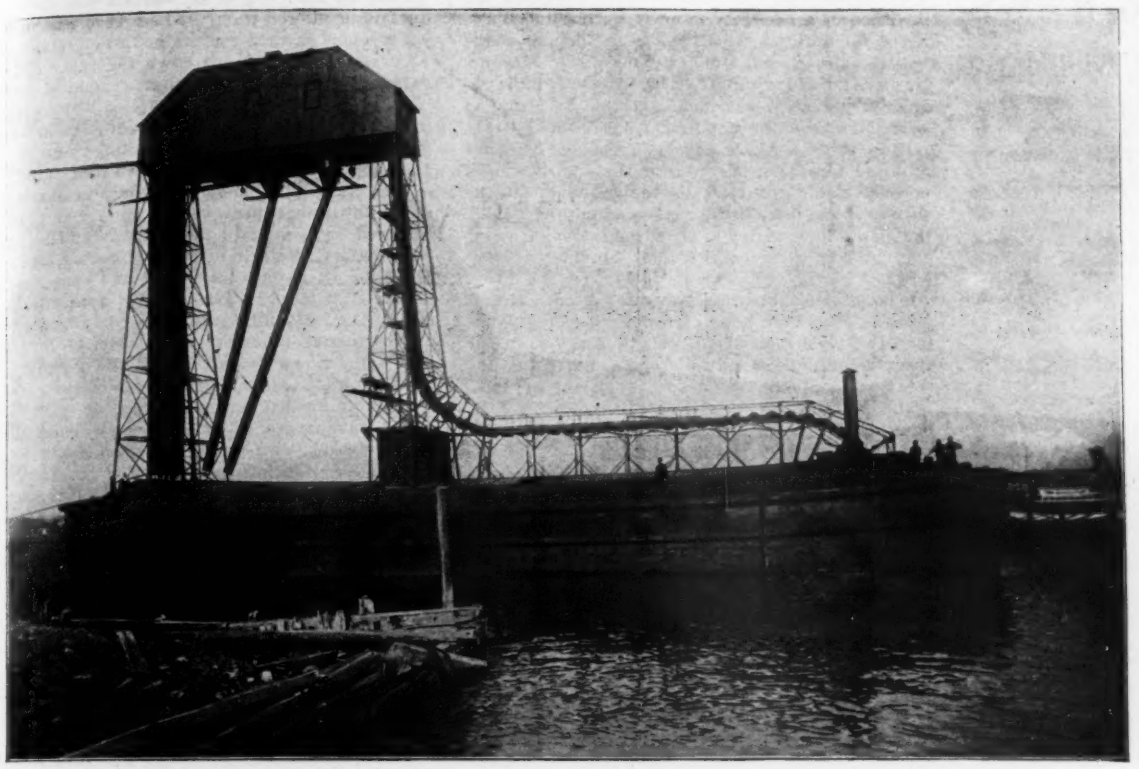

FIG. 8. GENERAL VIEW OF CLARKE COALING BARGE.

its highest position, with the next compartment in place to receive coal, and with the cutting off knife thrown back from the descending stream. A mechanical counting device on each scale registers the number of dumps, and the record is repeated by means of an electric connection to a register on the deck.

The barge being supplied with two scales, and running at the rate of 125 gross tons per hour, each scale will be dumped 250 times in an hour, or a little over four times per minute, thus allowing ample time for filling without shock. The accuracy of the scale is quite remarkable. Repeated tests under the most rapid conditions of working have shown that its mean error does not exceed one-fourth of 1%. Its durability has also been thoroughly tested; the two scales on the barge, after a year's use, are apparently as good as new, and have thus far required no repairs.

This automatic weighing and registering of the amount of coal delivered by the barge is a matter of considerable importance to steamship owners. By the ordinary methods of obtaining coal they must accept the weights given by the coal operators, and they have no satisfactory check upon the accuracy of these weights.

After the coal leaves the scales it slides down the telescopic chutes into the bunkers, where it is taken care of in the usual manner by the trimmers. By the use of a flexible end to the chute it is easy to carry the coal into the corner of the bunker, and thus greatly diminish the trimmers' labor.

The whole crew of the barge consists of six men: 1, the captain, who handles from the deck the levers operating all the machinery; 2, the engineer and fireman; 3, a man at the overhead winch to handle the chutes; 4, a man to oversee the filling of the bunkers; 5, a man in the scale house, who acts as a look-out; 6, the cook.

The operation of coaling a vessel is done entirely without the assistance of any of the vessel's crew, and without the use of any of its winches or tackle. There is only a small quantity of coal in motion at any one time, but it is moved so rapidly and quietly, and without any interference with the work of unloading or loading cargo, as to be scarcely noticeable.

The work done by the barge during the past year has been largely educational, coaling many individual steamers belonging to different lines so as to get vessel owners and agents acquainted with it. It is the intention to take the barge to Philadelphia, Baltimore and other points, to show by practical demonstration what it can do. A new company is being organized for the purpose of regularly handling coal in New York harbor. It will have its own coal docks, where it will receive coal by rail and a fleet of barges, so that there will be no delay in coaling vessels immediately upon their arrival in port. There is every reason to believe that when a sufficient number of barges can be built the new method of coaling vessels will entirely supplant the old, and become as universal as is now the elevator system of handling grain. The officers of the Automatic Coaling Barge Co. are:

President—J. S. Nugent, vice-president of the National Folding Box & Paper Co., and capitalist.

1st Vice-President—J. G. Dettmer, of the Peoples' Trust Co. and the Royal Baking Powder Co., of Brooklyn.

Treasurer—H. M. Smith, 1st vice-president and cashier of Bedford Bank, Brooklyn.

General Manager—P. B. Clarke, the patentee of the mechanical devices used in the barge.

All of the above are directors in the company, as well as E. G. Blackford, president of Bedford Bank, Brooklyn. A. T. Leward, capitalist, No. 180 Hancock St., Brooklyn, and Hon. F. H. Wilson, Postmaster, Brooklyn. The two larger photographic views, Figs. 8 and 9, show a side view of the barge, and also a view of the barge in position coaling a steamer.

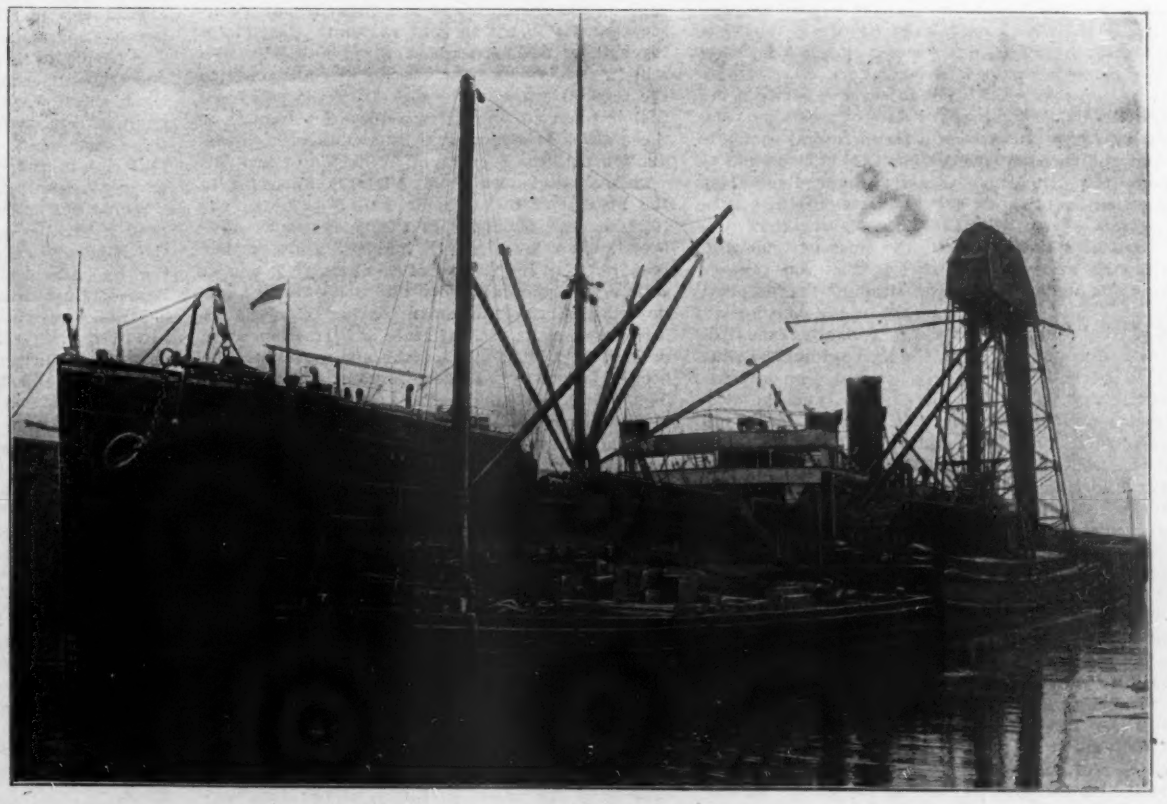

FIG. 9. VIEW OF BARGE IN OPERATION, COALING A STEAMER.

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In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 321 *means that subscription is paid to the* 32d *week (that is the issue of Aug.* 8) *of the year* 1901; *the change of these figures is the only receipt, unless one is sent by special request.*

ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXI-XXIII. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

Thirty-four days seems like a very short time-allowance for the installation of a garbage disposal plant with a daily capacity of 450 tons, but that is all that is given under the call for bids now being advertised in New York city. Moreover, only two weeks' time intervenes between the first advertisement and the date of receiving bids. Perhaps such a course will result in real competition, and perhaps it is designed to, but one has to know but little about either garbage disposal or city politics to throw grave doubts on either supposition. Practically the same tactics were displayed at Phfladelphia, at the close of 1900, and although everyone was surprised at the appearance of a second bidder, and although the low price which he bid forced the award of the contract to him, the contract was never formally executed. The contractor did begin the garbage service, but after a few days the police descended on him for unsanitary disposal of the garbage, and the contractor for the previous year took up the work. In New York, or what is now Manhattan Borough, a contract for removing the garbage from the city dumps by scows and treating it by reduction works at Barren Island has been in force for several years. The contract expires on Aug. 1. Under the present call for bids, contractors are invited, ostensibly, to compete for this work, putting in their bids on June 27 and having all their equipment ready for service by Aug. 1. This is simply another illustration of the folly of short-term contracts for certain classes of municipal work, to which we have previously alluded. Bidders under such conditions must either figure abnormally high, so as to recover the whole cost of their plant within the contract period, or they must count on the ultimate protection of their interest in some such way as the foregoing. In the long run the city is bound to suffer, in either case.

On another page of this issue we publish a description of a new system of preparing and burning powdered fuel, which has been adopted in the boiler plant of the Alpha Cement Co., at Alpha, N. J. At various times we have recorded the results of previous experiments in this field, and in most instances our impression has been that the results obtained were unsatisfactory. The plant required for the production of the fuel has been expensive and troublesome, the operation of the furnaces has been irregular, and, on the whole, the plants have failed to show the increased economy and efficiency which their promoters expected.

It is notable that while previous systems, almost without exception, have been developed by inventors, the present one has been worked out in the effort to provide a suitable system of firing the rotary cement kiln.

The first rotary kilns were fired with oil fuel; but this was too expensive to compete with coal, and the rotary kiln was in danger of abandonment on this account. In order to make it a success it was necessary that it should use coal as fuel, and under the pressure of necessity a successful system of dust fuel burning was created and is now in extensive use wherever rotary kiln cement plants have been established.

Naturally, the success obtained with the powdered fuel in the cement kiln led to its adoption under boilers. While conditions are quite different there, and the difficulties encountered are much greater, the facts recorded in our descriptive article indicate that a reliable and economical system of boiler firing has now been developed. Dust firing may yet become an important competitor of the automatic stokers and the smokeless furnaces which have been so extensively installed in large power plants during the past dozen years.

It is interesting to note in connection with this plant the influence exerted by the increase in wealth upon engineering methods. The present abundance and cheapness of capital renders it possible and advisable to install often the most expensive machinery, when by so doing the running expenses of a plant may be slightly reduced or labor troubles avoided. As engineering knowledge becomes more general and organization more perfect, the power-plant engineer is enabled to devote a larger part of his attention to the saving of small wastes. For example, an economizer will be used to recover heat that would otherwise escape up the chimney, and in a plant recently constructed for a cotton mill in South Carolina a regenerator has been added in order to recover a still further amount for heating the air going to the furnace. One of the objects of the powdered fuel burning process is to reduce the amount of these gases to a minimum by avoiding the introduction into the furnace of an excess of air.

This same tendency is strikingly apparent in the history of the steam engine. Although the fundamental principles of thermodynamics have been known for nearly a hundred years, it has been only by the saving of small wastes, one at a time, and the successive addition of minor improvements, that the steam engine has slowly progressed to its present state of perfection. The present high efficiency of the steam engine has been attained by an accumulation of small savings. And these improvements have been possible mostly because capital has become so plentiful that a great deal of it may be invested for a small yearly return. That automatic valve gears, steam jacketing, and superheated steam are good things from the standpoint of fuel economy was known long ago, but they are being adopted only as the interest and maintenance charge against them becomes less than the value of the fuel that they will save.

As the world advances in scientific knowledge and engineering skill, it is becoming more and more true that increase of wealth results in both the conservation of nature's stores and the saving of human effort.

A number of salient points relating to water filtration were brought out by the paper and discussion on the Lawrence filters, at the American Society of Civil Engineers, on June 5. Mr. Allen Hazen, M. Am. Soc. C. E., showed how the introduction of filtered water at Lawrence, and pure water from natural sources at Lowell, Mass., and Newark, N. J., had cut down the typhoid death rate; or in other words, that a polluted supply may be so purified, as reflected by typhoid rates, as to compare favorably with one naturally pure. At the same time, as pointed out by Mr. Hazen and others, a seemingly slight fall-off in the bacterial efficiency of filters is dangerous since experience proves that it is likely to be followed by a marked increase in typhoid fever. Fortunately, there is no need of such a decrease in efficiency, if only intelligent and conscientious supervision is provided by the authorities in charge. A naturally pure supply is no guarantee of continuous immunity from typhoid fever, as has been shown repeatedly by the typhoid epidemics traced to one or two cases of the fever in a sparsely settled drainage area.

The advantages of covering slow sand filters were indicated by a number of speakers, including Mr. Collins, who has had charge of the Lawrence filters for a year or two back. Mr. Collins showed how rain as well as snow and frost, interferes with and increases the cost of operating uncovered filters, like those at Lawrence. Mr. Geo. I. Bailey, M. Am. Soc. C. E., basing his opinions on his own experience with covered filters at Albany, N. Y., was very confident that there are great economies in covered filters. One important saving which they effect is the lost time due to bad weather, which is bound to occur with open filters. The paper and discussion alike emphasized the poor economy of operation due to having the whole filtering area in one compartment, as at Lawrance, and also the great need of more economical means of handling sand at filter beds, in order to reduce the cost of operation. In conclusion, it may be noted that the attendance at the meeting and the discussion of the able paper presented by Messrs. Knowles and Hyde, attested the interest in water purification now prevalent, and illustrated the great usefulness of a well-conducted engineering society as a means of bringing out valuable information.

CAR TRUCKS, CAR WHEELS AND DERAILMENTS.

Many years ago, the late A. M. Wellington propounded the question, why are derailments more frequent on American railways than on English? The old answer to this query was that it was due to the poor track of American railways, and abroad this idea still survives. Mr. Wellington, however, if memory rightly serves, held that it was chiefly to be ascribed to the difference in car construction, the English cars having a long rigid wheel base, while all American cars are mounted on trucks, or "bogies," as the English call them, which may be twisted into a position diagonal to the car body under some circumstances, resulting in derailment.

We do not call attention to this matter here, it need hardly be said, for the purpose of praising the English type of car construction or criticising the American type. The long rigid wheel base of English cars would not be admissible on a large proportion of the mileage of American railways, with their sharp curves. What we do desire to point out is certain features in connection with the design of rolling stock which, while familiar to some, are not, we believe, appreciated as they should be by all car designers. The very fact that derailments are less frequent in England than in America is worth careful study by those responsible for the safety of railway travel. It suggests at once the question, what changes can be made or what precautions taken in the design of American rolling stock which will reduce the risk of derailment and resulting disaster?

Let us consider the action of a truck rolling on a railway track. In Fig. 1 a single pair of wheels, mounted on an axle, is shown at A. Such a truck may be skewed out of place and derailed by a very small force. Where such a truck is actually used, as, for example, for the leading truck of a mogul locomotive, a radius bar is added as at B, secured to the frame of the locomotive and preventing the axle from being turned askew of the track.

At C, D and E are shown four-wheel trucks,

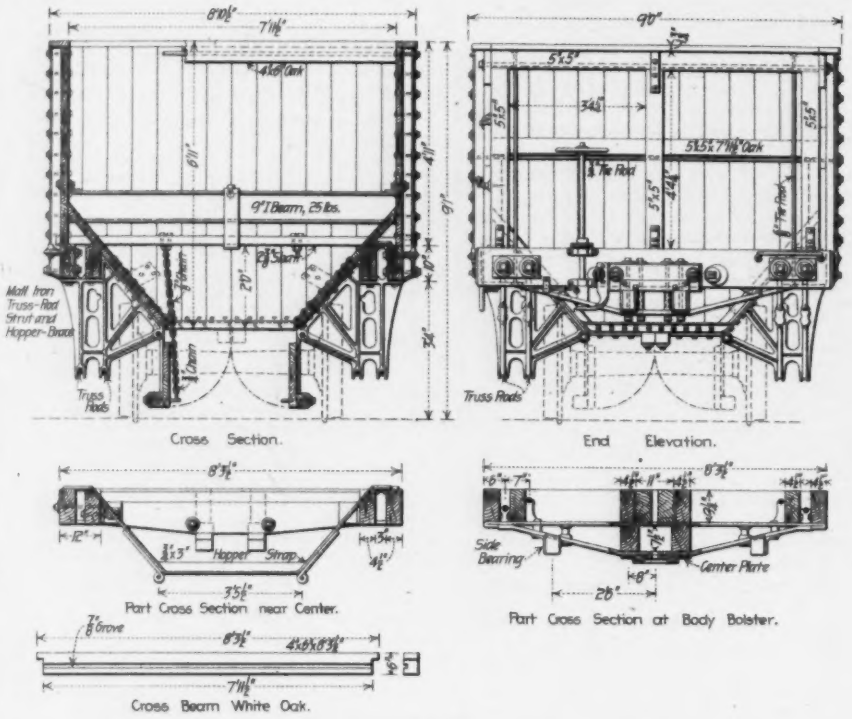


FIG. 3. END ELEVATION AND CROSS SECTION.

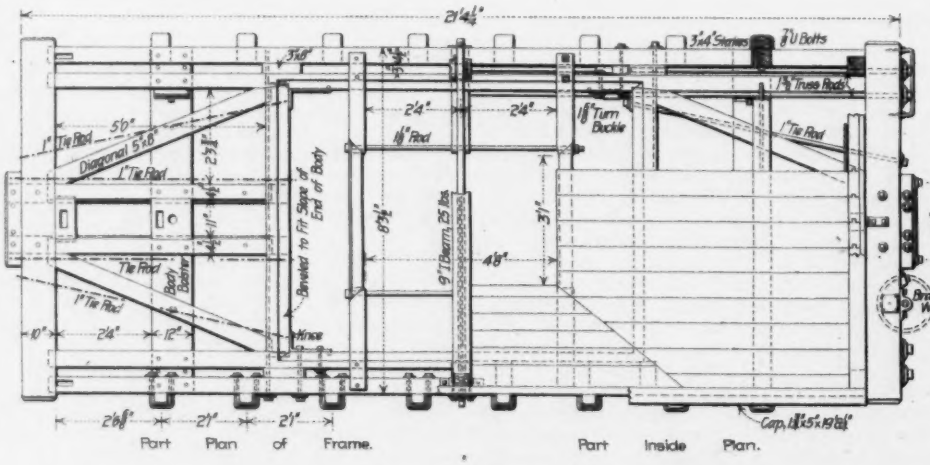


FIG. 1. GENERAL PLAN.

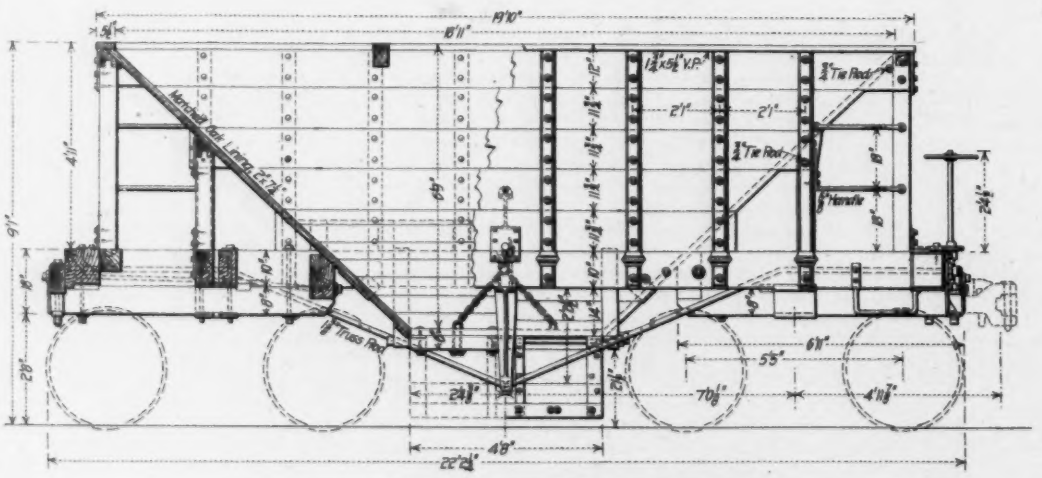
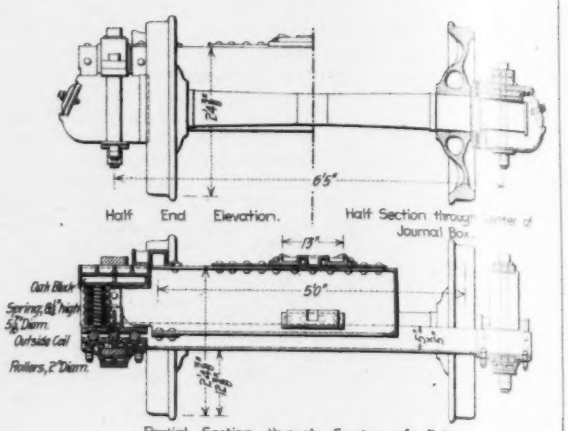


FIG. 2. SIDE ELEVATION AND LONGITUDINAL SECTION.



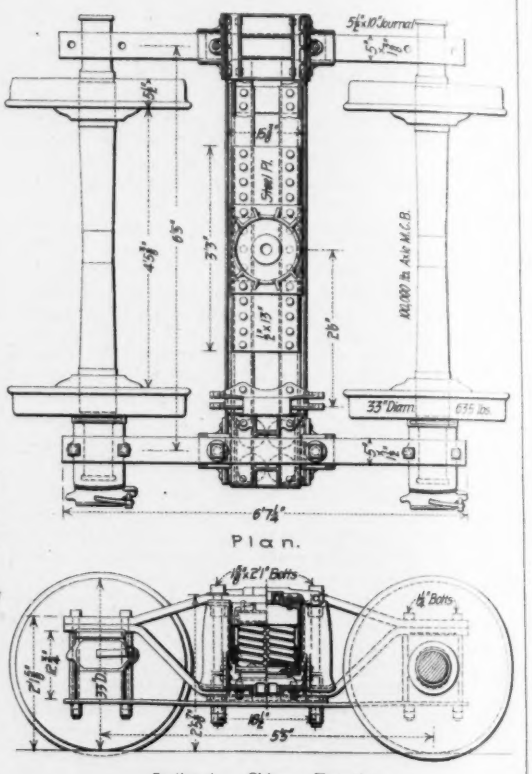


FIG. 5. DETAILS OF TRUCK.

100,000-LB.

ORE CAR.

Chicago,

Milwaukee

& St. Paul Ry.

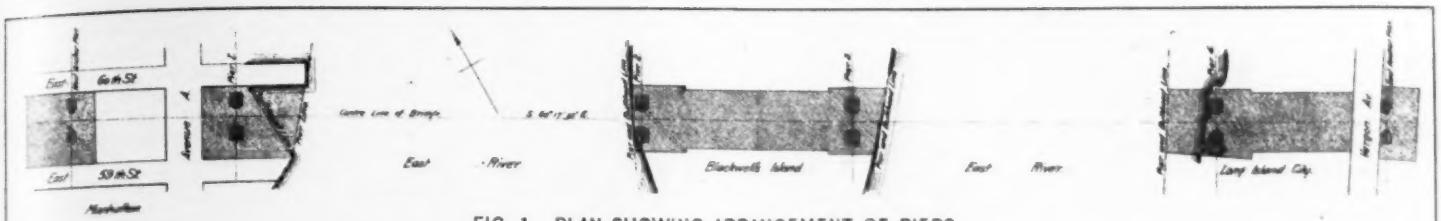


FIG. 1. PLAN SHOWING ARRANGEMENT OF PIERS.

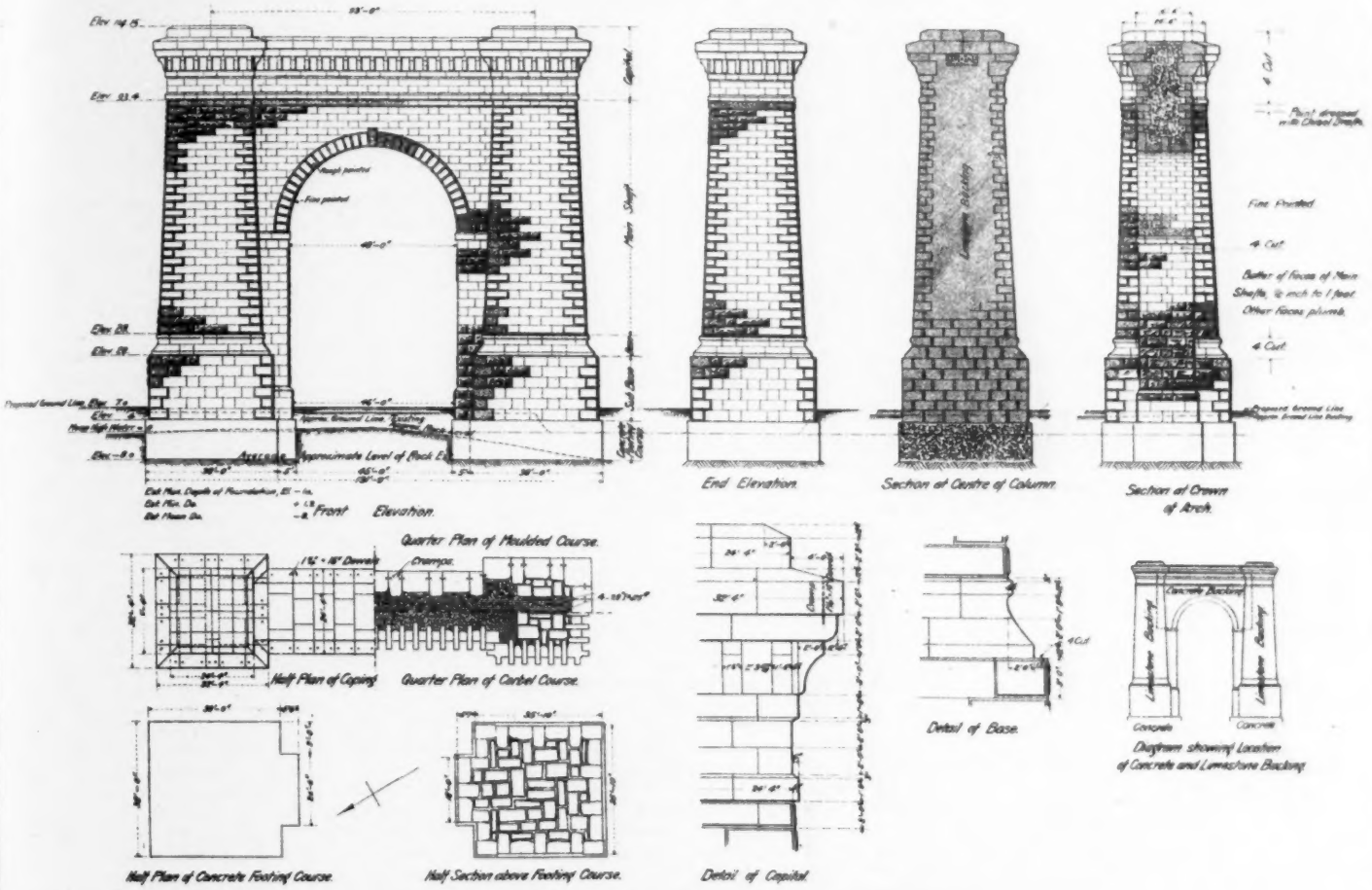

Front Elevation.
End Elevation.
Section at Centre of Column.
Section at Crown of Arch.
Quarter Plan of Moulded Course.
Half Plan of Coping.
Quarter Plan of Corbel Course.
Detail of Base.
Diagram showing Location of Concrete and Limestone Backing
Half Plan of Concrete Footing Course.
Half Section above Footing Course.
Detail of Capital

FIG. 2. DETAILS OF TYPICAL MAIN PIER CONSTRUCTION.

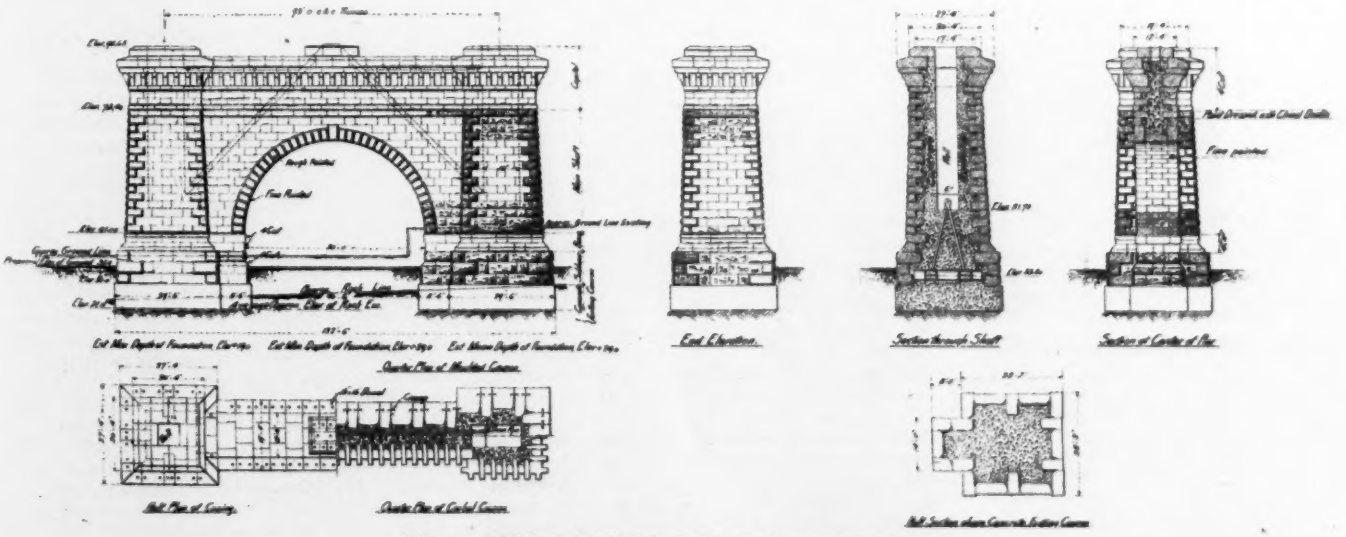

End Elevation.
Section through Shaft
Section at Centre of Pier
Half Plan of Coping.
Quarter Plan of Corbel Course.
Half Section above Concrete Footing Course.

FIG. 3. DETAILS OF ANCHORAGE PIER CONSTRUCTION.

MASONRY PIERS FOR FOURTH EAST RIVER BRIDGE, NEW YORK CITY.

John L. Shea, Commissioner of Bridges.

Samuel R. Probasco, Chief Engineer, Department of Bridges.

R. S. Buck, M. Am. Soc. C. E., Chief Engineer in Charge.

CHAS. HART, LITH., 90 VESEY ST., N. Y.

ith different lengths of wheel-base. It is evident that in any of these trucks one pair of wheels serves to guide the other pair, and the longer the wheel-base of the truck the greater the leverage exerted to effect such guiding. The late J. N. Lauder, for many years Superintendent of Motive Power of the Old Colony R. R., once compared the action of the leading wheels of a four-wheel truck to the pole of a wagon, and remarked that the longer the pole, or the longer the wheel-base of the truck, the more easily and surely would the guiding be effected.

Of course, it is not to be forgotten that if the

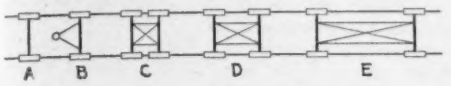


Fig. 1. Various Types of Car Trucks.

wheel-base is made too long, there may be difficulty in passing around sharp curves; but there are very few four-wheel trucks on American rolling stock which give any trouble in this way. On the other hand, it is at least worth considering whether some of the freight car trucks with wheels set close together (of which C, Fig. 1, may be considered an exaggerated example) would not be improved from the point of view of both safety and durability if the wheel-base were increased and more guiding power given. Is it not the case—to appeal to experience—that freight cars are far more frequently derailed than passenger cars, and may not one cause be the longer wheel-base of the passenger car trucks?

Let us consider next the resistances which are offered to the turning of the trucks as the car passes around a curve. It will be understood that as the car enters any curve, the trucks are turned slightly with reference to the car body, and the connection between the body and the truck must be such as to permit this turning. Fig. 2 (from the Master Car Builders' Proceedings for 1900, p. 166) shows a typical freight-car body bolster and truck bolster and their connections. It will be seen that the main weight of the car is transmitted to the truck by center plates, the one fastened to the body bolster and the other to the truck bolster. Of course, such a support alone would be too unstable to meet the centrifugal force on curves, lurches due to uneven track, unequal loading, etc., hence side bearings are added, as shown, which are in theory supposed to carry no load at all except when side sway occurs.

Every time a car enters or leaves a curve the trucks must be turned by the flanges of their leading wheels, so that they will stand at an angle to the car body varying with the sharpness of the curve; and as the car passes from the curve to a tangent the trucks must be set straight again. The force that must be exerted to effect this swiveling of the trucks will depend on the amount of friction which these center and side bearings offer.

Unfortunately, it appears to be the case that the increase of weight and capacity of freight cars in recent years has been attended with no corresponding increase in the capacity of center plates. In the report presented on this subject by a committee of the Master Car Builders' Association a year ago it was shown that cast-iron plates, malleable iron plates and pressed steel plates had all alike failed to give satisfaction. Many cases were reported where center plates seized or became rusted fast together. When such a car has to pass through a curve the strain thrown on truck members and wheel flanges can be imagined. In fact, the committee reported that cars had been repeatedly sent over 18° curves, and in nearly three-quarters of such cases the adjustment of the truck to the curve was made in the truck frame, and the center plates did not move at all.

Quite as important as the matter of center plates is that of side bearings. The center-plate concentrates its resistance over a disk of perhaps 12 ins. diameter at the center of motion. The side bearing presents its resistance at a distance of some 30 ins. from the center. The accepted theory of car designers has long been that the center bearing should carry all the load and the side bearings operate only to restrain lurching, standing clear of each other under normal conditions. This theory, however, is exceedingly difficult to carry out in practice. Both the bolster attached to the car body and that attached to the truck will inevitably deflect under load. If the side bearings just miss each other when the car is empty, they will be together hard and fast and carrying a good share of the total weight when the car is loaded. If it is attempted to avoid this difficulty by giving greater clearance when the car is empty, then the car may lurch badly when running empty or only partially loaded. Besides this, too, the lurching of a car on its side bearings when too great clearance is given between them places a great strain on the center plates and king bolts, since at every such lurch the entire weight is thrown on one edge of the center plate. It is not at all improbable that some of the difficulties complained of with center plates are due to this very cause.

It must not be forgotten in studying this problem, that we are dealing with large forces. The standard 60,000-lb. freight car body, with its load, transmits a weight of probably 20 tons to each of its supporting trucks. That such a weight must offer a great frictional resistance to the swiveling motion of the trucks, when applied under the conditions described above, can readily be understood.

The practical evidence of this resistance are numerous. Derailments and broken wheel flanges we have already alluded to. Increased train resistance and rapid wear of wheel flanges are likewise important. A car with large friction in its center plates resists the effort of the wheel flanges to turn the truck, and every time it leaves a curve the wheel flanges are held hard against the rail

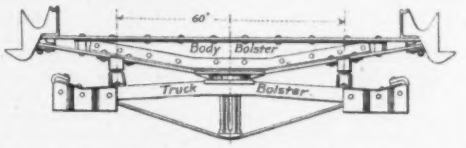


Fig. 2. Cross-Section Showing Method of Supporting Car Body on Truck.

for a considerable distance. The Baltimore & Ohio R. R., some years ago, we believe, established a regular system of center-plate lubrication and effected thereby an important reduction in the train resistance.

An extremely important aspect of the question is in connection with the use of cast-iron wheels under cars of very large capacity. Recent statements have been quoted to the effect that the safe carriage of 100,000-lb. cars was beyond the limit of cast-iron wheels having standard flanges. Since an increase in the thickness of the flange is practically impossible, it has been claimed that large capacity cars would have to be fitted with steel tired wheels.

The true answer to this statement seems to be that the work thrown on the flange must be reduced, and this can be done by reducing the resistances now offered to the swiveling of the trucks.

Excellent reports were presented on side bearing and center-plate construction at the Master Car Builders' convention a year ago, but no action was taken upon them, and the subject is again to be brought forward at the convention to be held in Saratoga next week. It is to be hoped that action may be taken for the adoption of definite standards. The preceding discussion has established, we trust, that the matter is intimately connected with the safe running of trains.

Without attempting to discuss in detail the design of center plates, it may be said that the most important matters to be covered are apparently the provision of ample strength, sufficient bearing surface and provision for lubrication. Pressed steel center plates appear to bend too easily to give satisfaction. It will be apparent that any such deformation must greatly increase the resistance to motion. Either cast or malleable iron plates give good results, provided only that sufficient metal is used to give ample strength. While elaborate finish of the rubbing surfaces would give no advantage commensurate with the cost, something a little smoother than the rough castings as they come from the foundry ought to be afforded. For lubrication some grade of graphite grease would appear superior to oil, since it would stay in place much longer, especially if the center plate were designed to retain it. It will be a long time before regular lubrication of car center plates can be secured on railways generally, and the motion of center plates is so small that one filling of grease ought to do service from the time a car leaves the shop till it returns to it for general repairs. As for the proposals to use ball-bearings or roller bearings under center plates, it need only be said that they do not deserve serious consideration. For side bearings, however, some form of anti-friction bearing ought to be possible, and seems, indeed, about the only satisfactory solution of a difficult question. If it is not, then some means of adjusting side bearings ought to be provided, so that they can be set to check lurching of the loaded car without carrying much, if any, of the load. To run cars which are down hard on their side bearings as railways are now doing is costing thousands of dollars in wear of wheels, wear of rails and increased train resistance, to say nothing of the constant risk of accident.

LETTERS TO THE EDITOR.

Tables for Setting Angle Stakes.

Sir: A letter published in your issue of June 6 describes a method for setting angle stakes in laying out roads, in which the author used a table computed for the special purpose. The table there reproduced is of limited application as regards fractional values of deflection angles, and it can be used for no other than the one stated width of road without making an arithmetical computation. Moreover, such tables if adopted would add wholly unnecessary matter to the field books.

These problems may be solved with the utmost facility by the use of the slide rule and the familiar tables of secants or cosines. Should tables of trigonometric functions not be at hand, the scales of sines and tangents found in the under side of the slide will readily produce results which, it is believed, will be within allowable limits of error in all ordinary cases.

Yours very truly, Edward M. Boggs.

534 Stimson Block, Los Angeles, Cal., June 12, 1901.

The Operations of the Lawrence Water Filter Plant—Corrections.

Sir: The writers beg to call attention to some minor errors appearing in an editorial, entitled "Some Comparative Figures Relating to Slow-Sand Filtration at Lawrence, Mass., Albany, N. Y., and Mount Vernon, N. Y.," published in Engineering News, issue of May 30, 1901.

On page 396, near the bottom of the third column, the statement that "the Lawrence pumps, however, which deliver upon the filter beds, etc.," is now misleading, but would give a correct impression if the last clause were written, "which deliver water from the filter beds into the distributing reservoirs, etc."

On page 397, at the bottom of the first column, the clause "up to July, 1898," appearing in the description of the item of conveying sand, should be omitted, and under the description of washing, the words "temporary dumps" should read "permanent dump." Prior to July, 1898, sand from the permanent dump was carried to the washer by means of wheelbarrows. Sand has never been transported from the temporary dump on the lower driveway by means of the jet in the portable hopper.

Respectfully, Morris Knowles.
Charles Gilman Hyde.

Spring Garden Pumping Station, Philadelphia, June 10, 1901.

The Eccentricity of Object-Glasses in Telescopes.

Sir: Some of your correspondents having discovered that certain engineer's transit instruments do not trace a straight line, have thereupon advanced the amazing theory that that defect is due to eccentricity of the object-glasses of the telescopes. In the absence of any proof that eccentricity could produce such an effect, is not this a little premature?

The telescope of a transit instrument is made up of the optical parts and the brass mounting which carries them, and if the latter is so constructed that when the object-glass is moved out or in to focus it, its motion is not rigorously parallel to the line of collimation defined by the cross-wires, then the transit will not trace a straight line. I am aware that most instrument makers deny the possibility of such a state of affairs, but Messrs. W. & L. E. Gurley, of Troy, N. Y., recognize its existence, and for many years have put a special adjustment in all their instruments in order to correct it.

It is perfectly safe to predict that if any transit or level, which fails to trace a straight line is examined, it will be found that its telescope is not in adjustment for col-

mation upon both near and distant objects; or in other words, the slide carrying the object-glass does not move parallel to the line of collimation defined by the cross-wires.

Very respectfully,

William Harkness.

99 Mercer St., Jersey City, N.J., June 13, 1901.

Railways of New South Wales—Correction.

Sir: I write to ask you to make a correction of the note on the "Railways of New South Wales," on page 221 of your issue of Oct. 4, 1900. I omitted to notice at the time that Mr. T. R. Firth was mentioned as being Chief Engineer of the railways.

If you refer to the report of the Railway Commissioners you will find that Mr. Firth is designated "Engineer-in-Chief for Existing Lines." You will further notice that there is a total absence of any reference to construction excepting with regard to deviations and alterations of grades.

By Act of Parliament, the Railway Commissioners have control of existing lines only; new railways are constructed by the Public Works Department of New South Wales, and it is my special function as Engineer-in-Chief for Railway Construction to look after their construction.

Up to the end of May, 1889, my predecessor, Mr. John Whitton, was Engineer-in-Chief. At that date 2,182 miles had been constructed, and the balance, about 630 miles, has been constructed by myself. In addition, the 300 miles mentioned as being under construction are in my charge, and I am arranging to commence a further length of about 280 miles. When these lines are completed they will be handed over to the Railway Commissioners to work.

It is also part of my duties to construct the new tramways, which, generally speaking, are worked by electric traction, and only recently I completed the first portion of the central power station, providing about 5,000 HP.

Yours faithfully,

H. Deane,

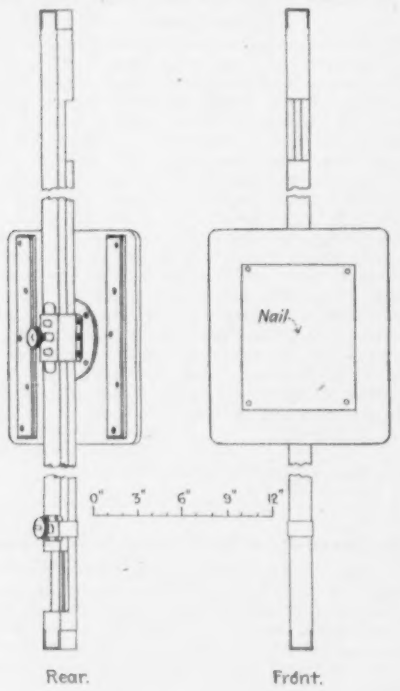
Engineer-in-Chief for Railway Construction, Public Works Dept. (Railway Construction Branch).

Sydney, N. S. W., March, 1901.

Another Tunnel Cross-Sectioner.

Sir, I have read with interest the articles in your issues of March 14 and April 4 relating to "cross-sectioners" for use in tunnels; more so perhaps on account of having been forced to devise a method for quickly securing reasonably accurate results, and with your indulgence I will describe it.

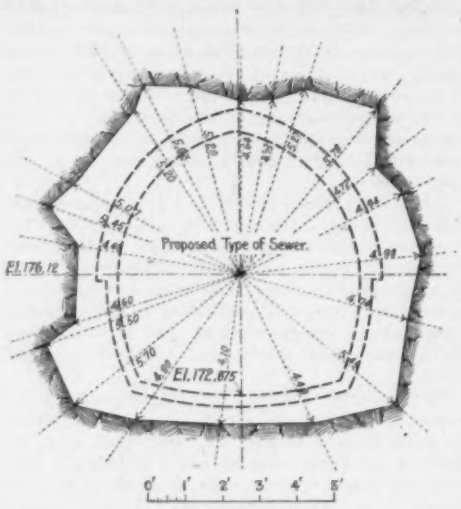
I first had a board of cherry finished to 12 × 14 × ⅝-in., cleated vertically on the back, fastening the back of this



to the face of the target of a New York rod by means of four screws, holes for which had been previously bored through the brass target, taking care to have the board square with the rod. To this board a block of paper was fastened, and at the intersection of the horizontal and vertical diameters of the board a small wire finish nail was driven through the paper into the board.

The bottom and top of the rod can be readily alined by an instrument, the rod clamp holding the rod when the upper portion is pushed up to the roof of the tunnel. The telescope of the instrument can then be levelled and the nail in the board adjusted to the same elevation, i. e., "height of instrument," and secured by the target clamp.

Up to this point one rodman will serve; then, while he holds the rod against any possible dislocation, another, with a measuring stick, graduated to hundredths of feet, places one end of the stick at a point of change in the perimeter of the tunnel, bringing the stick to the surface of the paper with one edge against the nail, scribes the line of radiation, noting the distance to the nail and recording it on the line, and so on until the complete perimeter of the tunnel is obtained. The date and station is noted and the sheet is torn off the block, the note-book supplying the elevation. With the appliance back toward



the instrument, the board may be brought to the desired elevation, the center of the target clamp screw being coincident with the nail in center of the board. By this method a cross-section can ordinarily be taken in about four minutes.

Upon reaching the office the measurements taken may be plotted on the lines as scribed and connected up, and the cross-section, the central elevation of which is known, can be transferred by tracing or pricking through to a sheet upon which the type of ultimate structure has been plotted. This method has proved accurate, has advantages of facility, and eliminates the opportunity for error of reading and noting direction. The accompanying sketches include one showing two views of the rod and attachment and one showing the notes as taken and plotted on a sheet showing a finished cross-section.

E. Elbert Young.

Auburndale, Mass., May 10, 1901.

Weight of Square Bale Cotton Presses.

Sir: I notice in your issue of June 6th, in referring to the paper read before the American Society of Mechanical Engineers by Mr. J. B. Fordyce on "Round Bale Cotton Presses," you state that the Fordyce press weighs only 15,000 lbs. as against 300,000 lbs. for the square bale press. I suppose this is an error on the part of some one, for we have yet to hear of a square bale cotton press that weighs much over 16,000 lbs. Our company here manufactures a substantial, well-designed square-bale press which when set up ready for operation weighs 14,000 lbs., including foundation sills; another square bale press of which the writer knows weighs complete 12,000 lbs., whereas some of the cylindrical presses weigh as much as 38,000 lbs. Yours very truly,

Eugene Couch.

113 Third Ave., Dallas, Tex., June 15, 1901.

(The error was due to a too hasty abstract of Mr. Fordyce's paper by our reporter. We quote the correct statement as it appeared in Mr. Fordyce's paper, as follows:

The round bale is made and pressed simultaneously. The square bale is made at the country gin, and then taken to a compress point, and its bulk reduced by powerful presses, weighing about 300,000 lbs. The round bale press weighs only about 15,000 lbs., and its bales are denser than the compress bales by about 10 lbs. per cu. ft.

It will be seen that the reference was to the powerful machinery used at compressing plants, and not to the ordinary baling press used at the gins.—Ed.)

Notes and Queries.

In the article entitled "Filters for Removing Oil and Mud from Boiler Feed-Water," appearing on pp. 436 and 437, of our last issue, the titles of Figs 2 and 3 were transposed.

THE U. S. COAL PRODUCTION IN 1900 amounted to 267,540,000 short tons, says the U. S. Geological Survey. This is an increase of 13,800,000 tons over the preceding year, and exceeds the English output of 1900 by 15,300,000 short tons. The value of the American output was $297,000,000, or nearly one-third the value of the total mineral product of the United States in 1899.

A NEW SYSTEM OF CONCRETE PILE CONSTRUC

The Raymond concrete pile system was giv public trial on May 16 at Chicago in an op near Sangamon and 22d Sts., where there deep stratum of sand. In this system a ta steel core is used, 20 ft. long, 18 ins. diamet the butt and 6 ins. at the point. In the ac panying cut the head of the core is shown The core is made in two longitudinal sect fitted together with a dove-tail joint and sec by a flat key, B, driven horizontally throu slot in the head of the pile. In driving a ho cap, C, is used, having guides which fit the l ers of the pile driver, while the center ha wooden block which rests on the pile head receives the blow of the hammer. The cor fitted with a taper shell of thin steel plate, which remains in the ground, and it is expect to be able to use a shell of heavy paper coil spirally in place of the steel. When the pil driven the key is withdrawn, and one-half t core is driven a few inches farther, which releases the joint and causes the core to collapse when it is withdrawn by means of the lug, L. The hole, with its steel or paper lining, is the filled with concrete.

In the above-mentioned trial the penetration for several blows was 1 in., with a 2,200-lb. hammer falling 25 ft. An oak pile was then driven a few feet away, this pile being 12½ ins. diameter at the butt and 10 ins. at the point. With the same hammer and drop the penetration was 5½ ins. per blow for several of the last blows. The greater resistance of the steel core is due to its considerable taper, and the bearing power of the pile is correspondingly high. The taper may be made greater for soft material or less for hard material.

This system of construction is intended specially for foundations for buildings, bridge piers, etc., and as it can be used in any kind of soil and without regard to the level of ground water, it

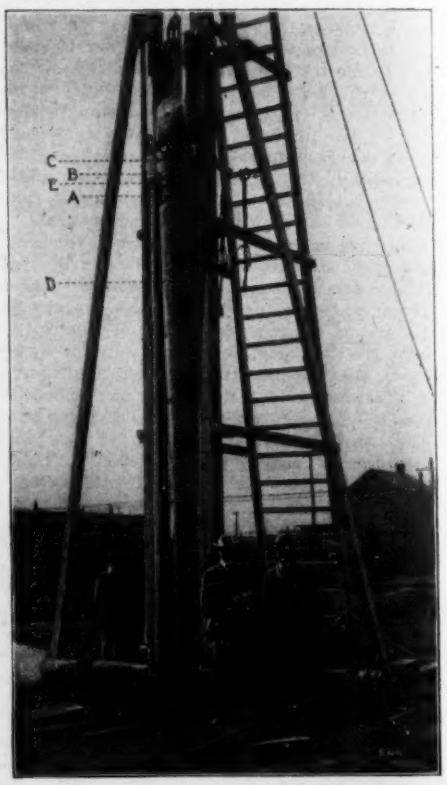


Fig. 1. Driving Steel Core for Concrete Piles. Raymond Concrete Pile Co., Chicago.

will in many cases considerably reduce the amount of excavation required. The cost is estimated at about 50 cts. per lin. ft. of pile. This system has been invented and patented by Mr. A. A. Raymond, who is seen in the photograph standing with his back to the ladder of the pile driver. It is being introduced by the Raymond Concrete Pile Co., 218 La Salle St., Chicago.

FIRE TEST OF THIN PARTITION BLOCKS and reinforced plaster and metal partitions was ordered by the New York Department of Buildings, on May 27. The contractors making these partitions were required to organize among themselves and to conduct experiments at a commercial testing station and on the same day, upon plans and specifications prepared by the Department. Notice is now given out that these tests must be made by July 1, 1901, and the drawings and specifications can be obtained from Mr. James G. Wallace, Commissioner of Buildings, 220 Fourth Ave., Borough of Manhattan.

AN EXPRESS STREET CAR SERVICE is reported as about to be started in connection with the lines of the Metropolitan Traction Co., of New York. Little detail is given out as yet; but it is understood that the express company proposes to gather and deliver by this means express matter, baggage and parcels all over the boroughs of Manhattan and the Bronx. Some doubts are expressed as to the power of the Traction Co. to engage in this business under its present charter.

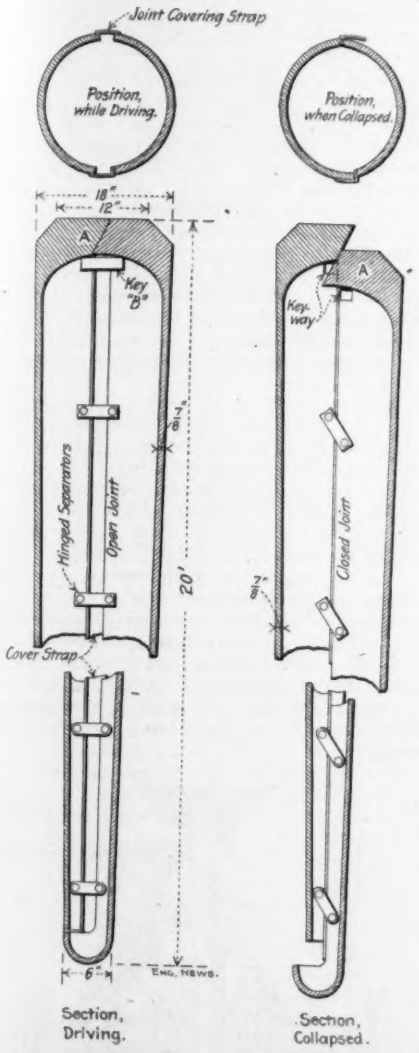


Fig. 2. Steel Core for Raymond Concrete Pile.

AN AMERICAN GRAIN ELEVATOR for Leith, Scotland, is to be erected by Botsford, Jenks & Co., of Port Huron, Mich. The plant will be American throughout, with all machinery brought from the United States. The elevator will have a capacity of 8,000 bushels per hour; and the storage bins will hold 1,000,000 bushels; electric power is to be used for operating the machinery, and the total cost of the plant will be $500,000. U. S. Consul Rufus Fleming, of Edinburg, says that while this port now handles 14,000,000 bushels annually of corn, barley and oats, cargoes are still lifted by the steam windlass system to wagons or cars, with no storage on the docks.

PRIZES FOR SELF-PROPELLING TRUCKS for military purposes are offered by the Secretary of State for War in England; the amounts being £500, £250 and £100; and the trials are to commence in England on Dec. 4, 1901. Competitors must send their names before Sept. 1, 1901, to the Secretary, Mechanical Transport Committee, Horse Guards, Whitehall, London, and fully dimensioned drawings and specifications, giving all details, must be sent to the same address before Dec. 4. These trucks must be capable of being used on rough roads and to some extent across country; they must go through an opening 7½ ft. wide; the net load to be 5 tons, of which 3 tons must be carried on the truck and 2 tons on a trailer; these weights to be exclusive of fuel and water. The total platform area to be not less than 15 sq. ft. for each ton of load; the top of the platform must not be more than 4 ft. 3 ins. above the ground, and that of the trailer, 4 ft. With a full load of 5 tons, as above, the truck should make a speed of 8 miles on a good level road, 5 miles on average roads, up and down hill, and should take its full load up a grade of 1 in 8. The driving wheels should not be less than 4 ft. 6 ins. diameter, and the tire not less than 9 ins. wide. The engines may use any fuel; but steam engines must be adapted to burning solid or oil fuel. No limit is placed on tare weight; but the total weight will be considered in the trials.

THE EXPORT OF MANUFACTURES FROM THE U. S. is discussed in the last bulletin of the Treasury Bureau of Statistics, in connection with similiar exports from other countries. The figures show that about 20% of the importations of Europe are manufactures: of Oceanica, 40%; of Asia, 47%; of America, exclusive of the United States, 47%; of Africa, 61%. As showing the healthy growth of exports of this class from the United States, we find that this export has increased, for Europe, 57% between 1893 and 1900; to Asia and Oceanica, our export of manufactures increased in the same period 291%, and to Africa, 235%. The bulk of our exports to Europe still consist of natural products, chiefly foodstuffs, but to other parts of the world manufactures constitute the larger part of our exports. Taking a few of these as examples, we find that the export of typewriters has increased from $1,453,117 in 1897, to $2,697,544 in 1900; that of sewing machines, from $2,793,780 in 1890, to $4,541,774 in 1900, that of scientific instruments, telegraph, telephone, etc., from $1,429,785 in 1890, to $6,435,766 in 1900.

AN ASSISTANT ENGINEER is wanted in the Department of Public Buildings, Lighting and Supplies for new York city, and a competitive examination of applicants is announced for June 21 by the Municipal Civil Service Commission, at 346 Broadway, New York. The engineer wanted must be thoroughly familiar with the design and erection of architectural iron work and general construction, and competent to take active charge of such work.

THOMAS CURTIS CLARKE.

Mr. Thomas Curtis Clarke, Past-President of the American Society of Civil Engineers, and one of the most prominent among American civil engineers, died at his home in New York city on June 15, after an illness of about two weeks. Mr. Clarke was born in Newton, Mass., Sept. 16, 1827, and he was the son of Samuel Clarke, M. D., and a brother of the eminent Unitarian divine, James Freeman Clarke, of Boston. After graduating from the Boston Latin School in 1844, and from Harvard College in 1848, Mr. Clarke studied engineering under Capt. John Childe, of Springfield, Mass., a graduate of West Point, and one of the first of army officers to achieve fame in the then new field of civil engineering.

Mr. Clarke first found active employment in his profession with the Grand Trunk Railway Co. of Canada, and remained with that company five years. He soon after removed to Philadelphia, and being early interested in railway bridge building, he became a member of the bridge building firm of Clarke, Reeves & Co., of Phoenixville, Pa., afterwards the Phoenix Bridge Co. But previously to this connection he had designed and built the second railway bridge over the Mississippi River, at Quincy, Ill. As the senior member of Clarke, Reeves & Co. he built a large number of bridges in various parts of the United States. Prominent among these were: The Girard Avenue bridge, over the Schuylkill, in Philadelphia; the famous Kinzua viaduct; a considerable part of the elevated railways in New York city, etc. In 1874, Mr. Clarke became a member of the Union Bridge Co., of New York, and as a member of that firm he was connected with the construction and erection of the Hawkesbury bridge in New South Wales, with foundations extending 185 ft. below high water, and the Poughkeepsie bridge, over the Hudson, with foundations 135 ft. deep.

After his retirement from the Union Bridge Co., Mr. Clarke engaged in consulting practice; he was engineer for the city for the Third Avenue Bridge, on the Harlem; and at the time of his death he was engineer of the Willis Avenue bridge, over the same stream. Mr. Clarke was the chairman and chief worker of the Engineering Committee appointed by the Merchants' Association of New York to investigate the needs of New York in its water supply, and primarily to stop the proposed Ramapo deal with the city. Mr. Clarke also designed a bridge proposed for crossing the Mississippi River just above New Orleans, La., but not yet built; was Chief Engineer for a time of one of the proposed bridges over the Hudson River, at New York; was Consulting Engineer for the West End Railway Co., of Boston, in connection with proposed subway construction; and was engineer of a multitude of other works.

As an engineer, Mr. Clarke was one of the first to introduce the use of concrete in large masses in the foundations and piers of bridges, and he shares with the late C. Shaler Smith the credit of first designing the modern metallic viaduct with braced towers and connecting spans. He has contributed many papers to technical societies and periodicals. Mr. Clarke became a Member of the American Society of Civil Engineers March 18, 1868, and was the President of that society in 1896; he was one of the founders and a Past-President of the Engineers' Club, of Philadelphia; and was made a Member of the Institution of Civil Engineers, of London, May 5, 1874, and he was awarded the Telford Premium and a gold medal for a paper on American bridges presented to the latter society. Mr. Clarke was married in 1857 to Miss Susan H. Smith, of Port Hope, Conn.; she survives him with five children.

PRESENT AND FUTURE CHILLED CAST-IRON CAR WHEELS.*

By William Fawcett.†

There is no material used in car construction that has to pass through such a severe and critical inspection as the chilled cast-iron wheel of the present day.

It is safe to assume that the wheel maker can easily meet the drop or thermal tests, and give the required depth of chill and also show the inspector a clean, soft grey iron plate in all test wheels when broken; but the life and mileage may still be unsatisfactory. It is not wisdom for the superintendents of motive power to arrogate to themselves the right of absolute dictation in having the plates of all wheels when broken show a clean, soft grey iron, without any white or mottled appearance. It is well known to the progressive wheel manufacturer that a car wheel, to give six years' service under heavy loaded freight cars running at a high rate of speed, requires to be cast with a strong, mottled, hard, dense, close homogeneous chilling metal, which is known to them from long experience to have excellent qualities for wearing surfaces, and gives to the tread or chilled portion a close, dense-grained metal, possessing all the qualities of a steel-tired wheel. But the manufacturers are obliged to live strictly up to the specifications, to have their product pass inspection and show a clean, soft grey metal plate, regardless of the consequences which are sure to follow.

Car wheels by the present method are cast from one ladle of molten metal, and there can be no dividing line drawn between the chilled tread and plates. The elements in the molten metal that give a soft grey metal plate enter into the chilled portion of the tread, and the ill effects of it can be readily traced to the limited mileage, thus accounting for the short life of cast-iron wheels made in accordance with the railroad's own specifications. The slightest deviation from them would sacrifice a whole day's cast to the maker.

The lines are too closely drawn on the depth of chill. The difference between ⅝ and ⅞ of an inch makes too small limits to keep between, while at 1-32-in. above or below these figures, the inspector rejects the lot. Some of these inspectors come clothed with authority to make it unpleasant for the wheel maker, and are at times very exacting in all the requirements asked for in the specifications, it being much easier for them to be critical than correct in such matters.

It may be asked why the railroad officials should dictate to the wheel maker the exact depth of chill (no more or no less) and also demand clean, soft grey plates, and then specify six years' service guarantee with every wheel. Would it not be wisdom for them to leave the depth of chill and the softness of the plates to the discretion of the wheel manufacturer, or else make this uncalled-for inspection an absolute mileage guarantee, releasing the manufacturer from all further responsibility.

The gradual increase in weight and size of freight cars during the past five years has been so great, we do not believe it is wisdom for the wheel manufacturers to guarantee six years' service with wheels placed under heavy box cars running at a high rate of speed night and day, Sundays and holidays, making on an average 2,800 miles per month, loaded both ways to their full capacity. The

*Condensed from "The Iron Trade Review."
†St. Charles, Mo.

chilled cast-iron car wheel of the present time seems to be the target upon which all the big and little guns of railroads are trained; but they must not expect too much of wheels made strictly to their own specifications. The wheel maker is not at his best when his ambition is tied hand foot by a too closely worded specification.

It is safe to predict that before many years of the new century have passed, all chilled cast-iron car wheels will be manufactured in geographical centers where the resources, adaptability and advantages are present for that class of work. There seems to be a growing demand among the superintendents of motive power of some of the leading railroads for a better and more uniform grade of wheels than they have been receiving of late years. But before they can accomplish this, they will have to order all their wheels to be strictly made of a certain chemical composition, and specify that they must be cast from an open-hearth gas furnace metal

The writer has been asked by several railroad officials if wheel makers were prepared through their chemical laboratories to furnish wheels of any definite chemical composition that they may see proper to order in their wheel specifications. I must admit that they are not by their present methods of casting wheels. Carbon, sulphur and phosphorus will be the determining factors, and these three elements are unmanageable in a cupola. It is hard to realize the revolution that this development will cause in the car-wheel industry. It not only calls for new plants, but a radical change in existing ones, but in either case it cannot help but be beneficial in the end.

I have before me the working plans, and all the details of an ideal car-wheel foundry with a capacity of 1,200 wheels per day of 24 hours, designed with the view of continuous molding, pouring and putting the wheels into annealing pits. In connection with the molding department in this ideal plant are three open-hearth gas furnaces and four modern cupolas of the required capacity. It is not intended to take the molten metal direct from the blast furnace, but to go into the open market and buy a suitable quality of pig metal from different localities, and after sampling it carefully by competent men, charge it into the cupolas in various proportions and relative quantities. It would be melted in the best possible condition and poured into the open-hearth furnaces and kept there under a proper heat temperature until all the objectionable elements mentioned in the wheel specifications are taken out of the metal, and those required added and chemically united.

It is then drawn from the furnace in a proper-size ladle and removed from all further heat influence; the wheels are then poured from it at the same temperature, thus giving to the product an even shrinkage, a uniform depth of chill and physical strength far beyond the requirements for ordinary usage. There will be cast on each wheel a spur about 1½ ins. high. The wheel inspector on looking over each day's cast for foundry defects, will break off as many spurs as he may deem proper, and send them to the railroad's chemical laboratory where a careful analysis will be made for all the elements, and if they all come within the lines drawn in the wheel specifications, that day's cast will be accepted. If any of the elements are on the outside of those lines, that day's cast will be rejected.

The successful wheel maker of the future will be prepared to make wheels of any chemical composition desired. He will be able to control the carbon, sulphur and phosphorus, and keep them within very narrow limits. When these three elements can be regulated to a nicety, the wheels will be more uniform, their life more satisfactory, and the physical strength increased far above all future requirements, the depth and quality of the chill regulated to an absolute certainty and the wearing qualities of the tread greatly prolonged.

POWDERED FUEL FOR BOILER FURNACES AT THE ALPHA CEMENT CO.'S WORKS, ALPHA, N. J.

Among the many novel features introduced in the new cement works, recently built by the Alpha Cement Co., at Alpha, N. J., is the use of powdered fuel in all of the boiler furnaces. One of the 250-HP. Stirling boilers in the old works has been operated for a considerable time with powdered fuel; and the resulting advantages in economy of fuel and in labor convinced the engineers of the company that extension of the system was desirable. The equipment of this boiler and of the boilers in the company's new plant has been carried out by the Engineering & Powdered Fuel Co., of 701 Land Title Bldg., Philadelphia, Pa.

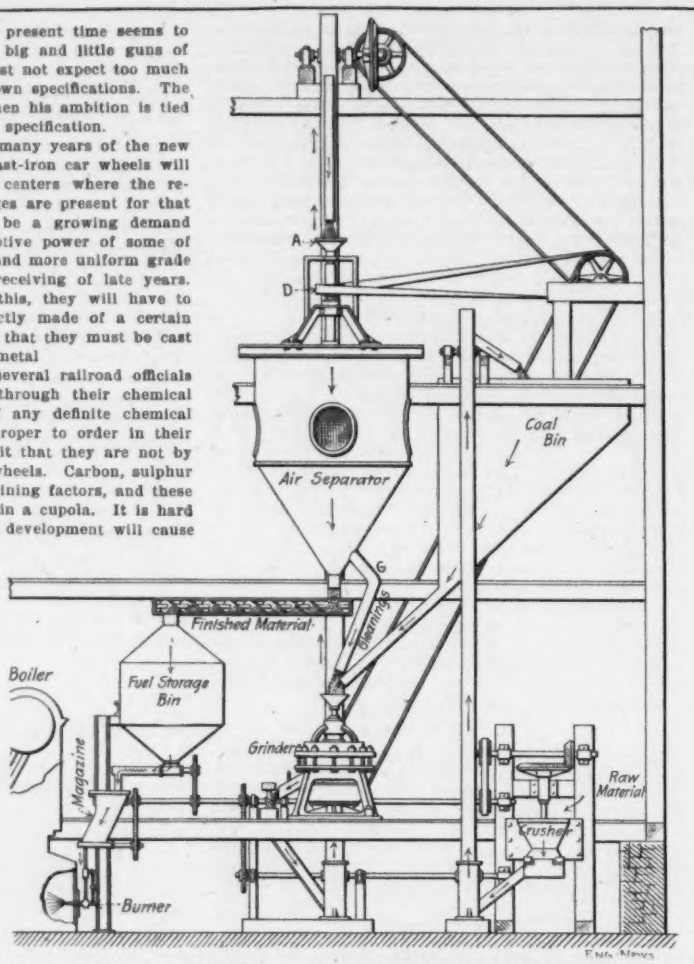


FIG. 1. SKETCH SHOWING GENERAL ARRANGEMENT OF PLANT FOR PREPARING POWDERED FUEL.

A member of the editorial staff of this journal visited the Alpha Cement Co.'s works on April 30, and witnessed the powdered fuel apparatus on the boiler above referred to in actual operation. He is indebted to Mr. G. S. Brown, Secretary and Treasurer of that company, for many courtesies and much information in regard to the working of the system. From the notes then made and from further information furnished by Mr. Wm. A. Mears, Treasurer of the Engineering & Powdered Fuel Co., the following description has been prepared:

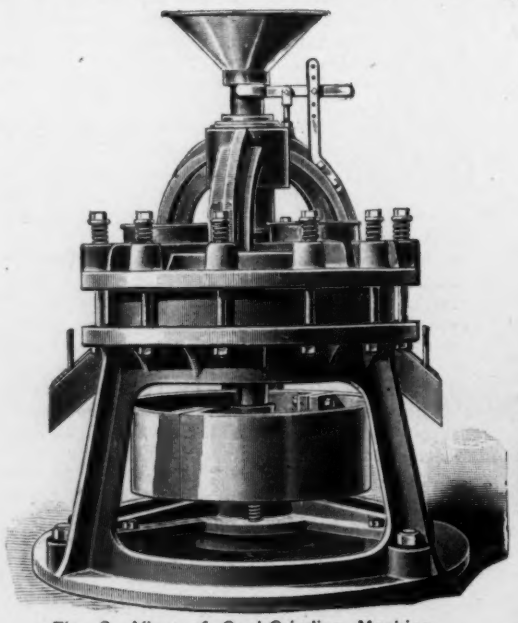


Fig. 2. View of Coal-Grinding Machine. Made by the Engineering & Powdered Fuel Co., 710 Land Title Bldg., Philadelphia, Pa.

The essential parts and general arrangement of a powdered fuel plant are shown in Fig. 1. The raw material, consisting of bituminous slack or other cheap coal, is first pulverized to about the size of "rice" or "buckwheat" coal, and then, if it contains more than 6% of moisture, it is passed to a dryer. The dryer used at the Alpha Cement Works was manufactured by the F. D. Cummer & Son Co., of Cleveland, O., and consists of a rotating horizontal cylinder heated externally by a furnace. A blast of air is passed through it to assist the drying. After leaving the dryer the fuel is taken to the coal storage bin by a conveying apparatus. From the coal bin the fuel is fed into the grinder, which is shown in elevation in Figs. 2 and 3. The grinding mechanism is shown in Fig. 4. Five balls are held loosely in pockets in the circumference of a rotating disk, and bear at the outside on a tire-steel ring. The fuel passes down the spindle of the disk and out through radial passages to the steel ring, where it is ground into an impalpable powder under the balls.

From the grinder the dust is carried to the air separator, the construction of which is shown in outline in Fig. 5. The dust falls down through the central passage A, which is surrounded by the quill B, bearing the vanes C and the pulley P. When the dust arrives at E, it is borne upward by the draft of air created by the revolving vanes and carried over into the outer shell, from whence it descends to the fuel storage bin. The coarser particles fall into the inner cylinder G, and thence back to the grinder. From the fuel storage bin the dust is carried to the magazine, from which it is fed to the burner. The magazine contains a suitable mechanism for feeding the dust uniformly and at any desired rate.

A diagrammatic sketch of the burner is shown in Fig. 6. The dust is delivered by a screw into the upper end of a vertical pipe. The bottom of the latter opens into a horizontal pipe, through which a jet of air is passing. The dust mingles with the air and is carried in a blast out of the open end of the pipe, or nozzle, which projects through the door of the boiler furnace.

In the furnace the jet of coal dust and air burns in much the same manner as a jet of gas, taking fire a few inches from the nozzle and burning without smoke. In order to start combustion it is necessary to build a small fire of wood, or other combustible in the furnace, but once in operation the heat in the walls and gases of the furnace is amply sufficient to ignite the incoming dust stream.

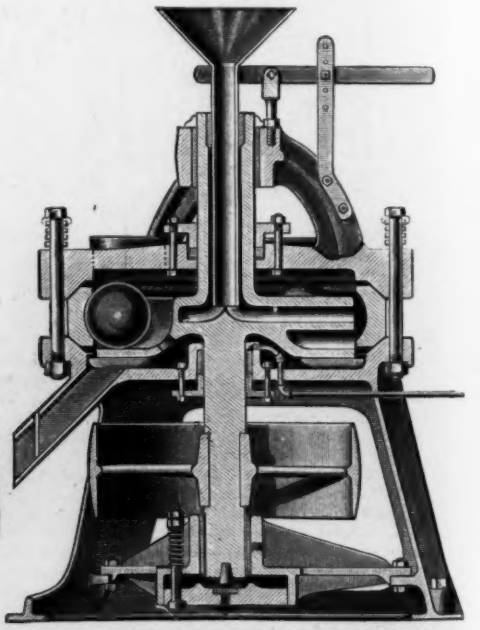


Fig. 3. Sectional Elevation of Grinding Machine.

When the air and fuel are regulated to nearly the proper proportions for complete combustion without excess of air, the heat is very intense, and the walls of the furnace must be constructed of the most refractory materials in order to withstand it. The destructive action is greatest at

where the flame impinges directly. The most suitable material for such places is silicon brick, although in the plant at Alpha it has been found that cement clinker stands very well.

The following results of a test made by Mr. De Kinder upon a return tubular boiler fitted with a dust-burning device, shows how perfectly the proper proportions of air and fuel may be maintained. It was found that when the furnace was on the verge of smoking, almost theoretically perfect combustion was obtained. The flame

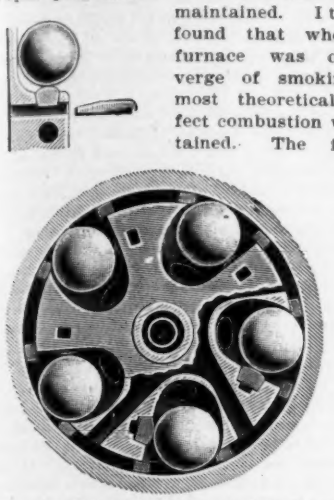


Fig. 4. Rotating Disk and Ball Race of Grinding Machine.

could be made either reducing, neutral or oxidizing at will. Below are given the results of volumetric analyses of samples of the escaping gases:

	CO_2.	O.	CO.	N.	Air used lbs.*
Sample No. 1.....	14.2	3.3	0.1	82.4	14.4
" " 2.....	15.7	1.0	0.9	82.4	13.0
" " 3.....	14.7	2.6	0.2	82.5	13 9
" " 4.....	14.3	3.1	0.2	82.2	14.3
" " 5.....	14.0	4.0	0.1	81.7	14.6
" " 6.....	15.5	2.0	0.0	82 5	13.2
" " 7.....	15.8	0.4	0.9	82.9	12 8

*Approximate.
(In each case a large sample of gas was collected over a period of about half an hour. From the large sample a small portion was withdrawn for analysis.)

Since, by giving the gases sufficient velocity, almost any amount of fuel and air may be forced through a furnace, the only limit to the capacity of a boiler plant using powdered fuel is the ability of the boilers to deliver dry steam. This is illustrated by two tests made on the 250-HP. Stirling boiler at the Alpha Cement Co.'s works by Messrs. H. Hitzel and H. Drew. The results of the tests are shown in the accompanying table.

Although the performance in the first test was nearly double the rated capacity of the boiler, the engineers state that 150 HP. more could have been obtained if necessary. The boiler upon which the tests were made is located in the open air, with no covering of any kind upon the six upper steam drumheads, consequently the loss by radiation was considerable. The first test was made after the boiler had stood idle in order to make changes suitable for using powdered fuel. The test was begun after firing the boiler moderately for ten hours. In the second test, which was made seven days later, the quantity of coal was reduced in order to get nearer the rated capacity of the boiler. Although the boiler had been in continual use day and night meanwhile, no cleaning of the tubes or boiler setting was made for this test. It may be stated, by the way, that a large proportion of the ash remains unaccounted for, probably passing up the chimney as dust. A small amount collects on the tubes and in the furnace, and is removed at intervals of once a week or so.

Boiler Tests with Powdered Fuel.

	Apr. 16, 1901.	Apr. 23, 1901
Duration of test.....	12 hrs	12 hrs.
Temperature of atmosphere...	47° F	55° F.
" " water.....	51° F	52° F.
" " gases in stack	550° F.	500° F.
Steam pressure, per sq. in...	120 lbs.	120 lbs.
Coal burned.....	15,720 lbs.	10,260 lbs.
Ash and moisture in coal....	11.65%	11.65%
Total amount of combustible	13,889 lbs.	9,065 lbs.
Water evaporated	137,674 "	89,175 "
From and at 220° F.....	166,760 "	108,080 "
Per lb. of coal.....	10.54 "	10.53 "
Per lb. of combustible....	12.0 "	11.92 "
HP. developed*	483	313
Coal consumed per hour.....	1,310 lbs.	855 lbs.
Analysis of coal used:		
Moisture	0.45%	0.45%
Volatile matter	29.75%	29.75%
Fixed carbon	58.60%	58.60%
Ash	11.20%	11.20%

*34½ lbs. water per hour at 212° F.

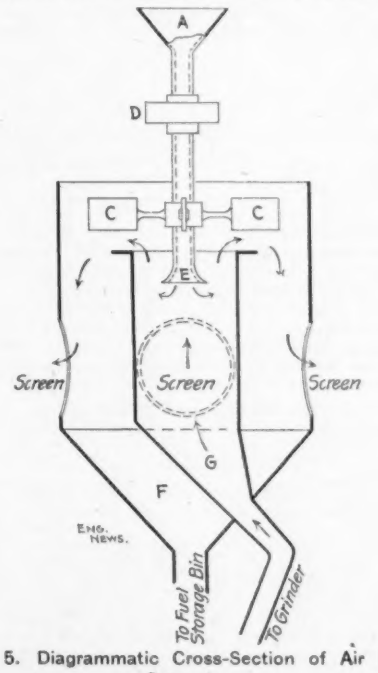


Fig. 5. Diagrammatic Cross-Section of Air Dust-Separator.

small amount collects on the tubes and in the furnace, and is removed at intervals of once a week or so.

The general advantages in using powdered fuel are now so well known that we need only enumerate them here: A cheap grade of fuel may be used; there is little labor in either firing or caring for the furnaces; if the air and fuel are properly proportioned there is a considerable gain in efficiency over grate firing; the plant may be pushed far above its rated capacity without loss in efficiency; and, what is often highly important, there is a complete absence of smoke. All of these advantages appear to have been realized in the present plant.

Many inventors have experimented with devices for burning powdered fuel, but difficulties have usually been encountered in handling the fuel and reducing it to the necessary fineness. The Engineering & Powdered Fuel Co. state that the best results are obtained when the coal is ground so fine that 90% will pass through a 150-mesh sieve. Coarser particles do not ignite so readily, and are apt to fall to the bottom of the furnace only partially burned. While no difficulty has been experienced in the firing of rotary cement kilns with a coarser grade of coal, it is to be attributed to the very different conditions under which a cement kiln is operated.

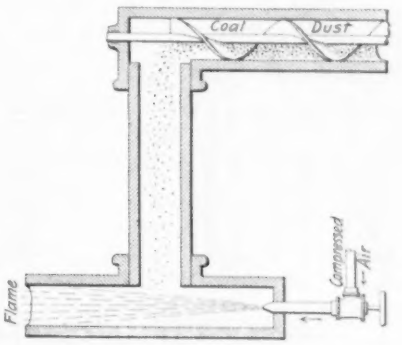


Fig. 6. Diagram of Powdered-Fuel Burner.

The finer the fuel, also, the easier it is to ignite. This brings us to one of the chief difficulties in using powdered fuel. It cannot be stored in any considerable quantity, nor confined in enclosed spaces without risk of spontaneous combustion. The apparatus here described, however, is designed to obviate this difficulty by powdering the coal only as fast as it is used, and keeping only a trifling quantity in storage.

The cost of pulverizing the coal will, of course, depend largely on the size of the plant. It is stated that in most cases it will probably be between 10 and 25 cts. per ton. The machinery for crushing, grinding and separating 75 to 100 tons of coal per 24 hours requires for its operation about 25 HP., or less than 1% of the power that the coal will produce when burned under a boiler to raise steam. It will be noted that this is a smaller amount of power than is used by some mechanical stokers.

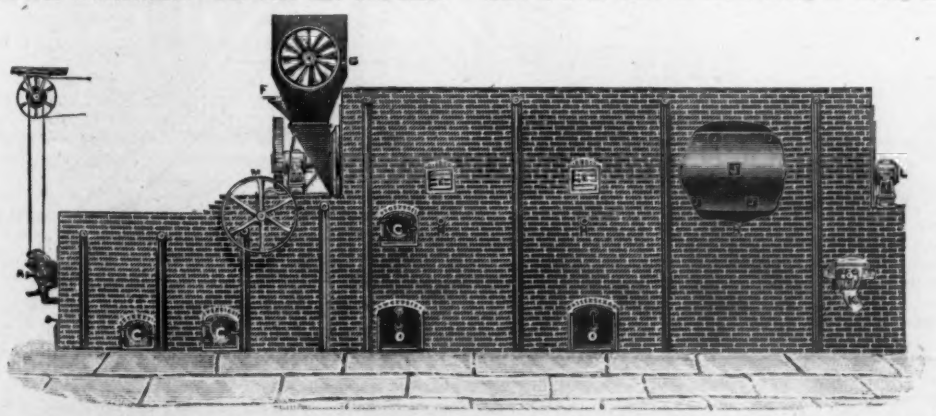


FIG. 7. DRYER FOR CRUSHED COAL.
Made by the F. D. Cummer & Son Co., Cleveland, O.

SUBSTRUCTURE FOR THE FOURTH EAST RIVER BRIDGE, NEW YORK CITY.

(With full-page plate.)

As noted in our issue of June 6, 1901, proposals have been asked for constructing the substructure masonry and foundations for the main structure of the cantilever bridge to cross the East River between Manhattan and Queens boroughs, and to extend over Blackwell's Island. The Manhattan end of the new bridge, as shown by the general plan, Fig. 1, will be between 59th and 60th Streets and it will cross the river at a slight angle to the main channels. The structure will consist of five spans carried by six piers, and flanked at each end by suitable approaches. The approaches will be steel trestle viaduct structures, and the main structure will be of the cantilever type. The following are the principal dimensions of the bridge:

Length of Manhattan approach	1,102.5 ft.
" " Manhattan anchor span	469.5 "
" " west channel span	1,131 "
" " Blackwell's Island	630 "
" " east channel span	984 "
" " Queens anchor span	459 "
" " Queens approach	3,455.1 "
Total length	8,231 ft.
Grades:	
Manhattan approach	3.41%
Queens	2.67%

The bridge will carry on two decks two sidewalks, two roadways, two double track trolley roads, and two elevated railway tracks. The elevated railway tracks will be carried above the other thoroughfares, all of which are on the same level.

The substructure of the bridge will consist of six piers, of which two will serve as anchor piers, and will contain the necessary anchors and anchor connections. With the exception of these anchors, the six piers will be substantially similar in construction. Each pier, as will be seen from Figs 2 and 3, consists of two main columns connected by an arch resting on pilasters. The facing masonry will be granite ashlar, and the backing will be limestone and concrete disposed as shown by the drawings. In the backing of each pier, just below the coping, there will be embedded an I-beam grillage consisting of four lines of 20-in.

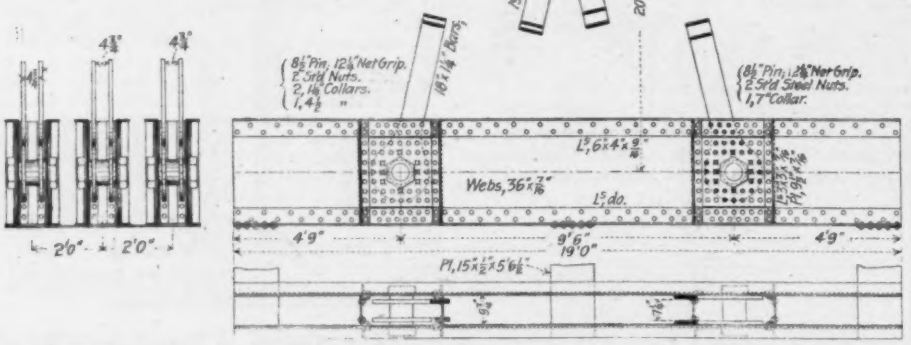


FIG. 4. DETAILS OF MAIN ANCHORS FOR ANCHORAGE PIERS; FOURTH EAST RIVER BRIDGE, NEW YORK CITY.

I-beams, weighing 75 lbs. per lin. ft. The anchorages for the anchor piers are shown in detail by Figs. 4 and 5. As will be noticed, there are two anchor systems; one to take the upward pull of the cantilever arms, and the other to handle the wind strains. The following is an abstract of the specifications for material and workmanship:

GRANITE MASONRY.—All granite must be equal to the best grade of Maine granite. It must be fine and uniform in grain and color, perfectly sound and free from sap, seams, dries, cracks or defects of any kind calculated to impair the strength, durability or appearance of the stone. All stones must be accurately cut with edges true to line. Beds must be parallel and out of wind. Stones must be laid on their natural beds. At the discretion of the engineer cavities may be allowed in beds, not more than 1 in. deep at any point, nor 75 sq. ins. in area, and the total area of such cavities in one bed shall not exceed 25% of the total area of the bed. No edge of any such cavity, however, shall approach the face of the stone nearer than 6 ins.

ROCK-FACED ASHLAR.—The masonry facing of the piers will consist largely of rock-faced ashlar, set with Flemish bond. The build of the ashlar courses will be generally from 3 ft. to 2 ft. The face width of headers shall generally be equal to but never less than the build, and the length shall be at least two and a half times their build. The dimensions of the rear end of headers must not be less than those of the face by more than 3 ins. in either direction; where concrete backing is used. Where limestone backing is used, the headers of the face ashlar shall hold their thickness throughout their length, but the rear ends may have a width 3 ins. less than the face. The face length of stretchers shall be not less than twice their build. Width of stretchers shall be not less than 1¼ times their build and shall hold their full face thickness for their entire width. All bed joints or rock-faced ashlar shall be ⅛-in. thick throughout. Vertical joints shall be ½-in. thick for a distance of 12 ins. back from the face, and at no point more than 3 ins. thick. The projections on the rock faces of ashlar shall not be more than 3 ins. nor less than 2 ins.

QUOINS.—The faces of the quoins shall be rough pointed to 1 in. projections, and all exposed edges shall have a 2-in. margin draft. The quoins on the bases and shafts of the piers shall stand out beyond the pitch lines of the ashlar 2 ins.

ARCHES.—The ringstones shall be set flush with the arch sheeting and stand out 2 ins. beyond the face of the spandrel wall. The soffits of the ring stones shall be fine pointed, and the faces shall be rough pointed, and have a 2-in. margin draft all around, beyond which there shall be no projection of more than 1 in. The ring stones shall be uniformly 4 ft. deep for the main piers and 3 ft. 6 ins. deep for the anchor piers. They shall have a length in the direction of the arch of 2 ft. 6 ins. and 5 ft., alternately, and shall bond with the arch sheeting, as shown on the plans. The arch sheeting shall be composed of alternate headers and stretchers, which shall course with the ring stones, the headers of each course alternating with those of adjacent courses. The soffit of the arch shall be fine pointed, so that variations on the surface from the pitched lines shall not exceed ¼-in. The coursing joints of the ring stones and arch sheeting shall be radial and together with the heading joints shall have a uniform thickness of ½-in. throughout. The string courses shall have a width or build at the soffit of about 2 ft. 2 ins. as nearly as may be. The stretchers shall have a depth or bed equal to the build, and the headers shall have a length not less than twice the build.

PEDESTAL BLOCKS.—Each pier shall be surmounted by two pedestal blocks. The stone shall be large and square, and all exposed surfaces, except the top, shall be 4-cut work. The top of the stones shall be rough pointed to 1 in. fulness, and after setting of the joints shall be dressed down to the required elevation, and to a true horizontal plane with 10-cut finished surface. The bed joints of the pedestal blocks shall be ½-in. and the vertical joints ¼-in.

COPING.—The coping course shall be of granite throughout and consist of large stones of the form and dimensions shown on the plans. All exposed faces shall be 4-cut work. The bed joints shall be ½-in. thick and the vertical joints ¼-in., except such as are covered by the pedestal blocks, which may be ½-in. thick. The interior coping stones over the arch may be thinner than the exterior stones, but in no case less than 12 ins. thick. The exterior coping stones shall each be doweled to the course below with two 1¼-in. round steel dowels 16 ins. long, disposed with equal penetration in the two courses connected. The holes shall be drilled through the coping and shall be filled flush with cement mortar after the dowels are placed in their position.

MOLDED COURSE.—The course immediately below the coping and designated as the molded course shall be constructed of large stone. From this course down only the facing stones will be granite. The exposed surfaces shall be 4-cut work. The bed joints shall be ½-in. thick throughout, and the vertical joints at exposed surfaces shall be ¼-in. thick for a distance of 12 ins. in from the face, or exposed surface, and nowhere more than ⅜ in. thick.

A grillage consisting of four 20-in. steel I-beams weighing 75 lbs. per foot, shall be embedded in the concrete of the molded course. The I-beams shall extend across the pier as shown, and may be laid in three sections efficiently spliced together. The beams must be spaced 2 ft. apart on centers, and the concrete carefully rammed about them to insure close and thorough contact with the steel throughout. The grillage for the anchor piers shall consist of channels and plates as shown on the plans, specially designed to assist in conveying the wind reactions from the center to the shafts of the piers. All joints between pedestal blocks and the steel connecting plates shall be filled and rendered thoroughly waterproof with asphaltic cement.

SETTING.—All stones in horizontal courses must be trial bedded, and after bedding must be lifted at least once, and as many more times as the inspector may require, to insure thorough bedding. Mortar for beds must be as stiff as can be readily worked. After bedding stones, all ½-in. and ¼-in. vertical joints must be filled with mortar carefully worked in with thin blades. Vertical joints of backing stones below the coping course will be filled with concrete, and the same thoroughly rammed with special rammers to insure a full and uniform joint. All face beds and joints must be raked out to a depth of 1½ ins., and, after completion of the pier, be pointed with mortar of one part of sand and one part of cement, driven in with a calking iron as dry as can be worked, and the surface of the joint struck with a round tool. Pointing must not be done when there is any danger of injury from freezing or rain.

CEMENT.—All cement used on this work must be the best quality of Portland cement.

BACKING.—Limestone backing shall be used throughout in the main piers, except in the footing course backing over arches and in that part of the molded course occupied by the steel grillage where concrete backing shall be used. For the anchor piers concrete backing shall be used throughout. Well holes of the dimensions shown on the plans shall be left open in each anchor pier. Each well hole shall be provided with two 1-in. galvanized iron drain pipes located as indicated on the plans. For a distance of 8 ft. down from the top of the coping the mold boards shall be constructed of dressed lumber, and the concrete shall be carefully deposited with a facing of mortar against the mold boards so as to leave a smooth finish

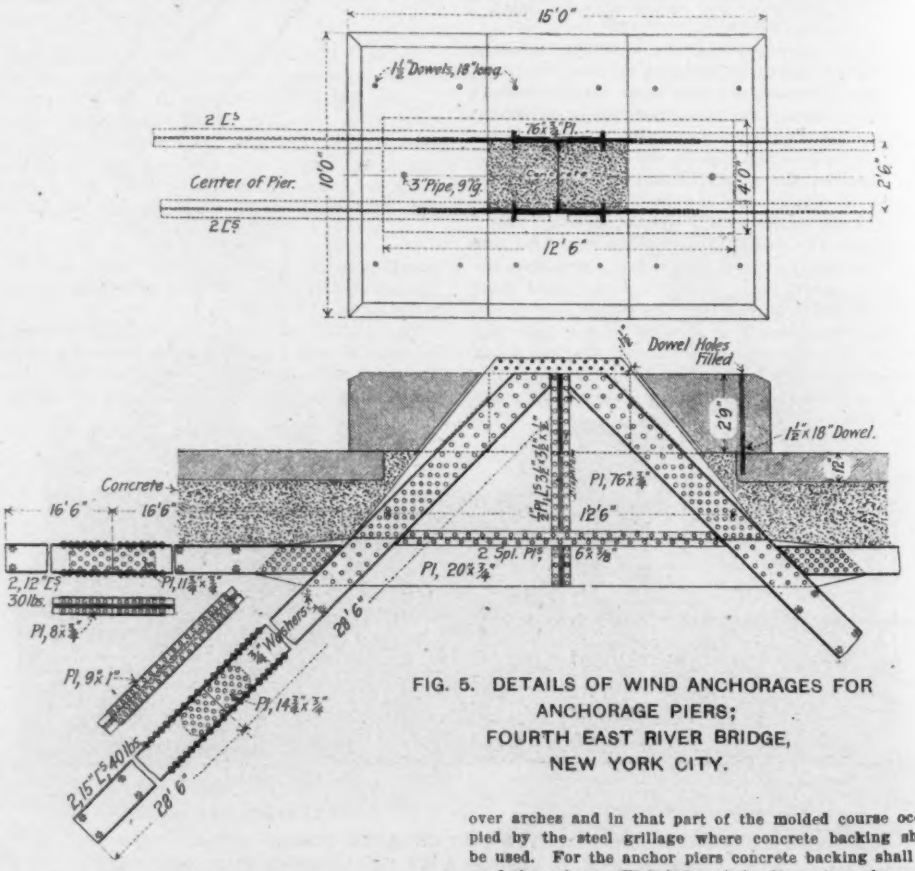


FIG. 5. DETAILS OF WIND ANCHORAGES FOR ANCHORAGE PIERS; FOURTH EAST RIVER BRIDGE, NEW YORK CITY.

...walls of the well holes after their mold boards are removed.

...KING STONES.—All backing stones, where specified, shall be limestone. That the build of the backing shall be the same as the corresponding face stones, and will be similar in general arrangement. No more than 10% of backing stones shall have less than 15 sq. ft. of bed area, and all must be approximately rectangular. Briquettes of neat cement exposed to air for 24 hours and then immersed in water for six days must have a tensile strength of at least 400 lbs. per sq. in. Briquettes of mortar mixed in proportion of one part of cement to 2½ parts of dry sand, by weight, exposed to the air for 24 hours and then immersed in water for six days, must have a tensile strength of not less than 180 lbs. per sq. in. Cement must be ground so fine that 90% of it will pass through a sieve of 10,000 meshes per sq. in. Pats of neat cement set in the air and then immersed in boiling water for 24 hours must show no checks or cracks.

...ND.—All sand must be clean, coarse and sharp, and free from mica, loam, clay or any other injurious material. For mortar, the sand must pass through a screen with clear openings of ⅛ of an in. sq. For concrete it must be from large pebbles.

BROKEN STONE.—All broken stone must be machine-broken and consist of the entire output of the crusher, except the dust, which must be screened off. The stone must not be uniform in size, but varying, so as to give the least volume of voids practicable. The broken stone for concrete filling about the I-beam grillages, anchor bars and backing in the molded course must be granite or trap rock. The maximum size of broken stone for filling about grillages and anchors and for vertical joints of limestone backing, will be ¾-in. on the largest diameter; and for concrete backing 2 ins. on the largest diameter.

MORTAR.—The mortar will be mixed in proportions of one of cement to two and one-half of sand by volume. It must be mixed only in small batches, either by hand or machine, and must be used within forty minutes after mixing. Sand and cement must first be mixed dry and then just enough water added to make the mortar sufficiently plastic for working.

CONCRETE.—The concrete must be, as a rule, machine mixed and only in such quantities as can be readily used before its initial set. The sand and cement must first be mixed dry, and then water in proper quantities added. Sand that is unduly wet shall not be used. Then the stone, previously well washed to remove all dust and dirt, will be added. Enough water must be used to render the mortar in the finally mixed concrete thoroughly plastic, and in condition to pack well when rammed, and be free from voids. All concrete will be mixed in proportions of one part of cement, 2½ parts of sand and five parts of broken stone by volume. One barrel or four bags of cement will be considered equal to 4 cu. ft. in volume. Sand must be lightly shoveled in the measure and not packed. Concrete shall be placed in layers from 8 ins. to 10 ins. thick, and thoroughly rammed until it forms a compact, uniform mass, and the water flushes to the surface. Ten-pound metal rammers will be used, as a rule. After ramming, surface of concrete must be kept wet until fully set. When a layer of fresh concrete is laid on a surface of concrete already set, the latter must be thoroughly cleaned and wet. Then a layer of mortar spread over the surface and the concrete placed. The concrete about the steel grillages and anchor bars shall contain broken stone of ¾-in. maximum size and where spaces are too small to admit this concrete freely, mortar must be used and carefully worked in so that all exposed surfaces of the steel shall be thoroughly covered and in contact with the mortar.

STEEL GRILLAGES AND ANCHORS.—In the several piers there will be steel grillages for the purpose of bonding the masonry thoroughly together and insuring a proper distribution of stress, arranged as shown in plans. The anchors in the anchor piers will serve to carry the upward reaction on the cantilever arms into the masonry of the anchor piers. All steel for plates, shapes, eyebars and pins shall be medium open hearth steel of 60,000 to 70,000 lbs. ultimate strength and elastic limit of 50% of the ultimate strength. It must show an elongation of 20% in 8 ins., and must bend, cold, without cracking, around a pin whose diameter is equal to the thickness of the test piece.

Rivet steel shall have an ultimate strength of 48,000 to 58,000 lbs. per sq. in., and an elastic limit of at least 50% of the ultimate strength. It must show an elongation of 25% in 8 ins., and bend, cold, flat upon itself without cracking. Pins must be forged under a steam hammer, and must be made from blooms at least three times the sectional area of the finished pins. Pin holes must be bored in built anchor beams after the latter are assembled and riveted up, and must be 1-50-in. larger than the finished pins they are to receive.

The bridge will be built under the direction of the Department of Bridges of the City of New York, with Mr. John L. Shea, Commissioner of Bridges; Samuel R. Probasco, Chief Engineer, Department of Bridges; and R. S. Buck, M. Am. Soc. C. E., Chief Engineer in Charge.

ANNUAL MEETING OF THE NATIONAL FIRE PROTECTION ASSOCIATION.

The fifth annual meeting of this association was held at Chicago, June 11, 12 and 13, the headquarters being at the Grand Pacific Hotel. The attendance was large, and there was no flagging in the interest evinced in the numerous reports presented. The President, Mr. C. A. Hexamer (Philadelphia), was in the chair, and at the opening meeting on June 11 he delivered the annual address, from which we take some extracts, outlining suggestions as to the lines in which the association can increase its usefulness:

The investigation of material and methods of construction tending toward reduction of fire waste has hardly been begun. With the help of the laboratories, and with assistance from the National Board, it is to be hoped that the question of fire-retarding materials, protection of metal members of construction, fireproofing of wood, etc., may be successfully considered.

One of the reasons why the standards and requirements so far adopted by this association have been well received and generally adopted is the fact that all of our committees have freely conferred with the manufacturers of devices involved and have enlisted their co-operation. The result has been most gratifying. It is my opinion that the insurance interests would be greatly benefited could this plan of conference and co-operation be extended to the relations between insurer and the assured, but I cannot recall a single instance in commercial intercourse where diversified interests come in contact with each other, where there is so apparent an antagonism as seems to exist between the insurer and the assured.

In his address at the fourth annual convention, President Crosby said: "A careful study of this problem in underwriting will convince the student that the interest of the companies from a purely selfish standpoint lies in improvement of risks; that profit is made in eliminating the cause of fires, increasing facilities for extinguishing same, and not in advancing rates." This statement has my unqualified endorsement. I would recommend that the incoming Executive Committee be instructed to consider the feasibility of investigating causes of fires by classes, with the view of tabulating them, and also to suggest methods of construction and protection tending toward their elimination. Such work carried on by a special committee with the co-operation of the assured must be an important factor in the reduction of the annual fire loss.

The report of the Secretary showed that the association now has 31 active members (stock fire insurance companies) and 49 associate members (individuals). The first report presented was that of the Committee on Blower Systems, which was read by Mr. Albert Blauvelt. After describing the installation and dangers incident to blower systems for heating, ventilating and conveying material, the following general recommendations were made:

BLOWER SYSTEMS.

1. Whenever a blower or fan used for conveying heated air for drying purposes is located in a room or box containing steam pipes, the bearings of the blower or fan must be located outside of this room or box. This can be done by the use of an overhang fan (without outboard bearings) or by longer shafting which passes entirely through the room. All bearings to be self-oiling and easy of access.

2. Drying systems should be so arranged that the fan or blower exhausts the heated and moisture-laden air from the dry room, blowing same out doors, or (as in a patented dryer) blowing the moist air over a system of cold-water pipes which condense and remove the moisture and then returning it to the dry room.

3. Wherever a fan or blower is used in connection with a carry-off pipe, to ventilate the space above a cooking range, the fan should be located at a point as far as possible remote from the range. If the carry-off pipe discharges outside of the building, the blower or fan should be located in a portion of the pipe outside of the building.

4. Whenever sheet-iron conveyor pipes are used as carry-off pipes, they must be clear of woodwork and treated in every respect the same as hot air or smoke pipes; sheet-metal flaps, arranged to close automatically in case of fire, to be provided.

5. Whenever a fan or blower is used to convey material of any kind and discharging into an enclosed space, a cyclone-dust collector should be used in order that the material may drop dead in the enclosed room, and the air escape outside, without back pressure in the fan or blower.

6. It is recommended that fans and blowers be of large size and low speed be used, rather than small fans or blowers at high speed.

7. All conveyor pipes to be of riveted sheet iron, joints to be soldered to prevent escape of air. Wooden conveyor pipes should be prohibited.

8. Sheet-iron pipes passing through brick fire walls from one building to another, to have fire doors at each side of the wall pierced, held open by fusible links and arranged to close automatically in case of fire.

This report gave rise to considerable discussion, particularly in regard to dust explosions and automatic sprinkler systems. A resolution was passed to the effect that it was the sense of the meeting that the pipes or mains of blower systems should be fitted with automatic sprinklers. The next report was that of the Committee on Fire-Retardant Treatments of Wood, an abstract of which we shall print next week. This was presented by the chairman, Mr. H. A. Fiske (Boston). The report of the Committee on Hose and Hydrants was read by Mr. W. H. Stratton (Hartford, Conn.), and we give below the specifications for mill hydrants as amended during the discussion. The committee had submitted draft specifications to 17 manufacturers, and the replies received were considered in making the fixed form.

SPECIFICATIONS FOR MILL HYDRANTS.

To prevent confusion and the possibility of unfounded criticisms we have specifically defined the hydrant proposed as for use in mill yards only, and it must be understood that it is not our intention to attempt reconstruction of hydrants for general use, although there are many points in these requirements that may be universally applied.

1. IRON.—The quality of iron, uniformity of thickness and conditions of construction and test, to be the same as specified for cast-iron water mains.

2. SIZE OF BELL.—This must be 6 ins. for two or three 2½-in. outlets and 8 ins. for four 2½-in. outlets.

3. INLET VALE.—(A) The size of valve inlet for two 2½-in. outlets must be 5¼ ins., and the size of valve inlet for three or four 2½-in. outlets must be 6¼ ins.

(B) It must be so constructed that, when opened, it will offer the least obstruction to flow of water and to present the minimum of friction.

(C) All the valve parts and surroundings must be of such material and strength as to withstand all strain or effect of corrosion, and must have a factor of safety that shall prevent the possibility of destruction when closed upon any hard material.

4. DRIP VENT.—(A) The outlet for automatically draining the hydrant after the valve is closed, must be of a vitreous or absolutely non-corrosive material, the opening to be at least ½-in. in diameter and as near the bottom of the barrel of hydrant as the construction will permit.

(B) It must not be tapped so that a plug can be screwed in.

5. ANCHOR LUGS.—Suitable lugs must be cast upon the hydrant so that it may be anchored by rods to the underground main.

6. AREA OF BODY.—The free area of the body for the flow of water must be at least 33⅓% in excess of the valve inlet, allowing for the obstruction made by rods or valve parts, and if any special make of hydrant offers extraordinary friction or obstruction it must be relieved by increased area.

7. FROST CASE.—Each hydrant must be provided with a loose frost case to positively prevent the lifting of the hydrant by freezing of the ground.

8. FLANGED JOINTS.—(A) Each hydrant must be provided with a flanged joint at least 4 ins. above the ground line, which shall permit the changing of the outlets in any direction.

(B) The lower flange to be drilled for 16 holes, the upper flange for 8 holes, in accordance with the steam fitters' standard templet. This will allow the adjustment of the outlets to 22½° points.

9. HOSE OUTLETS.—(A) The center of hose outlets must be about 18 ins. from the ground level.

(B) The center of the hose outlets must be far enough below the top of the hydrant to prevent the possibility of raising the wheel handle of the hose-gate high enough to interfere with the swinging of the wrench on top of the hydrant.

(C) The hose outlets or bushings must be attached to the hydrant either by a bolted flange or be screwed in. If the latter, they must be pinned to prevent turning when attaching or detaching hose.

(D) All outlets on three-way hydrants must be placed within limits of 150°.

10. HOSE GATES.—(A) Outside hose gates, preferably of a cheap strong pattern, with stationary stem, must be placed on each outlet. It is not essential that the valve shall be double-seated or positively tight; in fact, it is better to leak a little, as it is only intended to hold the volume of water when changing hose.

(B) The hydrant must be so designed that these valves may be attached by screwing in, using 3-in. standard iron pipe threads, and the openings shall be so arranged that when the valves are turned they shall not come in contact with one another or with the flange or top of hydrant and shall point in such direction and at such spacing as will permit the use of hose spanners to swing without striking other hose or valves.*

11. VALVE ROD OR STEM.—The rod operating the valve must be so attached or connected both at the valve and at the head that it will be impossible to become detached in operation, or from the raising of the body by frost.†

12. ROD OR WRENCH HEAD.—The rod head for applying wrench on valve rod and caps must be 1¼ ins. square.

13. WRENCH.—Each hydrant must be provided with a separate wrench to be shipped as part of the hydrant, and all wrenches shall be of universal thickness and length.

14. PROVISION FOR OILING.—The hydrant head and rod bushing must be susceptible of oiling for lubrication and to prevent corrosion.

15. OUTLET FOR TEST GAGE.—Each hydrant must have a hole drilled in the case back of the outlets, tapped for ⅝-in. iron pipe and plugged with a brass square head plug.

16. INTERCHANGEABLE PARTS.—All working parts which it may be necessary to repair or replace must be interchangeable in size and shape, and so planned as to compensate for the slight variation produced by corrosion or wear.

17. INTERIOR DESIGN AND FINISH.—All interior parts of hydrants must be so designed and finished to afford the least practical friction loss.

18. INDICATOR.—The main inlet valve shall be constructed so as to open by turning to the left, and the direction shall be indicated by an arrow and the words "Turn to open" cast upon the head of the hydrant in a clear and prominent manner.

The report of the Committee on Uniformity of Requirements was then presented by Mr. H. A. Fiske (Boston). This included a long list of requirements pertaining to building construction and fire protection. This was discussed item by item and very extensive changes were introduced. The consideration of this report occupied a large part of the time of the afternoon session of June 11

*On the model we have shown a means of attaching the outside hose gates to the hydrant without the use of an intermediate brass part. Heretofore it has been the custom to fasten into the body a brass nipple with a lead-calked joint and to apply the hose gate by screwing onto this piece. This reduces the area below 2½ ins. because of the depth of the threads, sometimes down to 2¼ ins. Our model shows the boss cast on the hydrant body tapped for 3-in. pipe thread and the hose gate provided with a thread or screw directly into the body of the hydrant. By this means we obtain a short, strong connection, doing away with the extra brass piece and making it possible to retain the full 2½-in. area through the valve and attachment. As this will change the patterns of all hydrants now in the market, we consider it desirable to decide upon an universal size and thread so that they will be interchangeable throughout the product of makes of hydrants or valves.

†In support of this item we submit two cases with the report and sketches of our inspector. In one instance the rod came off of the valve at the bottom of the body, and in the other, the operating nut came off the rod in the head of the hydrant. This is a very important feature.

and the morning session of June 12. At the latter session, the next report was that of the Committee on Electric Fire Pumps, which was read by Mr. C. M. Goddard (Boston). We reprint on another page some extracts from this together with the other reports on fire pumps.

The report of the Committee on Thermo-Electric Fire Alarms was read by Mr. F. E. Cabot (Boston), and gave a number of rules governing the construction of

THERMOSTAT ALARM CIRCUIT CLOSERS.

Low-test thermostats, if susceptible of adjustment to be set at 140° F.; if of the solder-release type, to be set at 160° F.; that is, the same formula for solder to be used as in the ordinary low-test automatic sprinkler. A variation in the above temperatures of 5° either way is allowable.

High-test thermostates to be adjusted or constructed so as to operate at 200° F. and 300° F.

Thermostat to be given hot-air rising temperature test. Temperature of surrounding air at start to be 100° F., and to be uniformly increased at a rate of 50° a minute.

Thermostats set at 140° F. must operate not over 190° F. Solder release 160° F. thermostats must operate not over 200° F.

The Committee on Devices and Materials reported progress only, mentioning its investigations into fire extinguishers, etc. This was presented by Mr. W. C. Robinson (Chicago). The report of the Commitee on Watchmen's Time Detectors was read by Mr. H. A. Fiske (Boston), and embodied recommendations covering a standard for watchmen's time-recording apparatus. This was discussed item by item, and the discussion was continued at the afternoon session. The report of the Committee on Steam and Rotary Fire Pumps was then read by Mr. W. H. Stratton, and will be found elsewhere. A very brief report of the Committee on Steel Rolling Shutters was read by the Secretary; no recommendations were made. This was followed by a lengthy report of the Committee on Wired Glass and Prism Glass Frames, which was read by Mr. W. C. Robinson (Chicago) and discussed by paragraphs. It laid down detailed rules for the construction of metal window frames and shutter frames. Some extracts as to wire glass and prism glass are given below:

WIRED GLASS AND PRISM GLASS FRAMES.

No wired glass shall be accepted of less thickness than ¼-in. (full) if rough plate, ribbed or figured; and no polished glass less than 5-16-in., same having been not less than ⅓-in. before being polished.

No wired glass shall be accepted with mesh larger than 1-in., and with such mesh no wire of smaller size than No. 22 B. & S. wire gage shall be used. Selvage must not be left on glass when framed.

Prisms, as installed for the purpose of increased light, are usually not contained in frames which are designed to withstand severe heat. The metallic ribbons between the prisms used for the purpose of light only, are not heavy enough, are not continuous and unbroken in both directions and are insufficiently attached to the metal border to withstand severe conditions of heat. The ribbons in one directions are usually formed of short pieces slipped in between the unbroken ribbons running in the opposite direction being held in position by the electro-glazing.

In frames for the service the ribbons are usually of comparatively light brass and are fastened to the metallic border by soldering and electro-glazing only. Canopy frames and frames under special conditions are made in a more substantial manner on account of the necessity for greater strength, but they are usually unsuited for use as a fire retardant.

It has been demonstrated by fire tests that prism frames constructed as described do not present sufficient fire resisting properties to warrant consideration. But they may be made reliable for this service. In all cases where prism frames are to be installed as a protection against fire they should be specially constructed for this purpose and framed in as careful and secure a manner as wired glass.

Mr. W. H. Stratton (Hartford, Conn.) stated that the Committee on Relative Fire Hazards of Various Methods of Baling Cotton had no report to make, as the Board of Underwriters had deemed it inexpedient to furnish the funds required for making tests. Mr. Albert Blauvelt (Chicago) stated that the Committee on Recommendations for Tests, Adjustment and Maintenance of Fire Apparatus in the Field, had not its report in shape for presentation. This ended the list of committee reports.

Before adjournment, the officers were all re-elected, as follows: President, C. A. Hexamer, Philadelphia, Pa.; Vice-President, J. W. Cochran, Columbus, O.; Chairman of the Executive Committee, W. H. Stratton, Hartford, Conn.; Secretary, E. U. Crosby, New York, N. Y.

On June 13, the association visited the Underwriters' Laboratories, under the charge of Mr. W. C. Robinson. Exhibitions were given of methods employed in testing hand chemical fire extinguishers, fire hose, automatic sprinkler heads, and the dry pipe valves for sprinkler systems.

100,000-LB. ORE CARS; CHICAGO, MILWAUKEE & ST. PAUL RY.

(With full-page plate.)

The new ore cars which are now being built at the shops of the Chicago, Milwaukee & St. Paul Ry., at West Milwaukee, Wis., are of special interest in showing what can be done in making large wooden cars of light weight. The cars are rated at 100,000 lbs. capacity, and will carry this load of both heavy and light ore, while it is expected that they will carry 10% overload constantly, or 110,000 lbs. actual load. The dead weight is only 29,400 lbs. The first cars of this type, which were built about a year ago, weighed 31,500 lbs., but as a result of the experience with them it has been found practicable to reduce the weight to 29,400 lbs., partly by cutting the side planks to the slope of the ends and by using malleable iron castings throughout, instead of ordinary gray iron castings. It might at first sight seem that the weight is too light for economical service, but 60,000-lb. cars of a generally similar type, and with about the same proportion of dead load to live load, have been carrying full loads for some 25 years, with results which warrant the designers of the new cars in claiming that they will be economical from a transportation point of view, and also in point of maintenance. The cubic capacity is 580 cu. ft., or 50.7 lbs. of dead load per cu. ft. of capacity. The steel cars which are now coming into such general use have in general a greater dead weight, although some few are lighter, but how these cars will rank in point of economy after several years' service remains to be seen. As one of the special features of the C., M. & St. P. Ry. cars is their shortness, combined with high-carrying capacity, they cannot well be compared with the ordinary steel cars for coal and ore traffic, which are usually 30 to 34 ft. long. They may, however, be compared with the 22-ft. pressed steel ore cars of the Great Northern Ry. and the Lake Superior & Ishpeming Ry. (Eng. News, Jan. 19, 1899), which are designed to discharge at ore docks having pockets 12 ft. c. to c.:

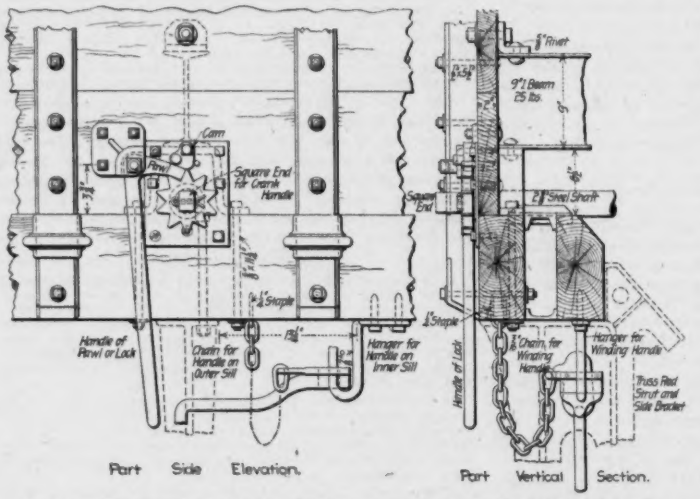


FIG. 4. HOPPER DOOR LOCKING AND OPERATING DEVICE FOR ORE CAR.

Railway	C., M. & St. P.	L. S. & I.
Car	Wood.	Steel.
Length	21 ft. 4¼ ins.	22 ft.
Rated capacity	100,000 lbs.	100,000 lbs.
Dead load	29,400 "	28,000 "
Live load	77.28%	78.12%
Dead load	22.72%	21.88%
Per ton of capacity	588 lbs.	560 lbs.
Cubic contents	580 cu. ft.	675 cu. ft.
Dead load per cu.ft. capacity.	50.7 lbs.	41.5 lbs.

The advantage of the short cars is that the spacing of the cars in a train corresponds to the spacing of the pockets of the ore dock, 12 ft. c. to c. By this means an entire train can be spotted into position and then dumped, instead of having to shift and spot each car, as is very generally the case with cars of ordinary length. The average load of the steel cars on the L. S. & I. Ry. is 96,000 lbs. The actual load varies with the character of the ore, and with some kinds of ore the cars can be loaded with 125,000 lbs.

The construction of the Chicago, Milwaukee & St. Paul Ry. car is shown in the accompanying cuts. Fig. 1 gives the plan; Fig. 2, the side elevation; and Fig. 3, the end elevation and cross-section. The framing consists of two yellow pine side sills and two truss rods at each side, framed into oak end sills. The side sills of each pair are 3 ins. apart. Two cross timbers are fitted where the sloping ends of the body pass through the framing, and between these and the end sills are fitted short or stub center sills of white oak, with diagonal brace timbers to distribute the buffing strains. Tie-rods 1 in. in diameter are fitted against the cross timbers and center sills, and diagonal rods of the same size run through from the end sills to the iron knees inside the cross timbers. This makes a very substantial f[illegible]ing to resist both pulling and buffing strains. The cars being short, the truss rods are bent [illegible]V-shape, with a single malleable iron strut, 2[illegible]2½ ins. deep, at the angle. Each strut tak[illegible]the two truss rods and has a wing supporti[illegible]he side of the hopper. The truss rods extend t[illegible]gh the body bolsters and the end sills, while t[illegible]le-rods of the center sills also pass through the [illegible]d-blocks. Under the stub center sills are oak [illegible]aft timbers, 5 × 8 ins., carrying the draft gear, [illegible]ich is of the Dayton double-spring pattern, w[illegible]M. C. B. couplers. These timbers are butted a[illegible]s the cross timbers of the frame. Malleabl[illegible]-fittings are used throughout.

The cars are of hopper form, with sides v[illegible]al above the sills, and the ends sloping unif[illegible]ly from the top to the hopper opening. The inclination is such (1 vertical to 1.08 horizontal) that it is practically impossible even for wet ore to stick or clog. The depth from top of body to hopper door is 6 ft. 9 ins. The sides are of yellow pine planks 2 × 11¾ ins., and the flooring is of oak planks 2 × 7½ ins. The sides are supported by stakes, and have two timber braces and two tie-rods across the top. The rods are supported by vertical braces and end posts.

The hopper opening is horizontal, 4 ft. 8 ins. long and 3 ft. 1 in. wide in the clear, and is closed by two doors which swing towards the sides when opened, being hinged to the inner side sills. Each door has two chains connected to the end of a chain which is wound upon a 2¾-in. shaft passing through the car above the sills, and protected by a 9-in. I-beam transom. On the end of the shaft is a star wheel, normally held by a locking lever or pawl, which is kept in place by a cam. When the car is to be dumped the cam is turned and the lever arm of the pawl thrown so as to release the shaft, when the weight of the load opens the doors. To close the doors, the shaft is revolved by a loose crank handle which is carried on a hanger on the inner sill when not in use. The door locking and operating devices are shown in Fig. 4.

The body bolsters are of steel plates, with malleable iron spacing blocks. The trucks, Fig. 5, are of the Barber type, with roller bearings, which type is largely used for heavy freight cars on this road. They have diamond frames and steel bolsters, with helical spring under the ends. They have inside hung brakes, with Monarch metal brake beams. The upper arch bars are 1½ × 5 ins.; lower arch bars, 1⅜ × 5 ins.; tie-bars, ⅝ × 5 ins. Between the lower arch bar and the tie-bar are fitted the bearings for three 2-in. steel rollers 10 ins. long, which allow for the lateral motion of the bolster in the frames. The general dimensions of the cars are as follows:

Ore Cars; Chicago, Milwaukee & St. Paul Ry.	
Length over end sills	21 ft. 4¼ ins.
" over body	19 " 10 "
" inside	18 " 11 "
Width over side sills	8 " 3½ "
" over end sills	8 " 8 "
" inside	7 " 11½ "
Height, rail to top of body	9 " 1 "
" rail to top of sills	4 " 2 "
Depth at nopper	6 " 9 "
Hopper opening	4 ft. 8 ins. × 3 ft. 1 in.
Side sills (4)	4½ × 10 ins.
End sills (2)	10 × 11 "
Stub center sills (4)	4½ × 10 "
Diagonal braces (4)	5 × 8 "
Draft timbers (4)	5 × 8 "
Side stakes	3 × 4 "
Truss rods (4)	1⅛ ins.
Trucks, diameter of wheels	2 ft. 9 ins.
" wheelbase	5 " 5 "
" distance center to center	14 " 0¼ "
" weight (of one truck)	7,850 lbs.
Journals	5½ × 10 ins.
Cubic contents (level full)	580 cu. ft.
Rated capacity	100,000 lbs.
Weight, empty	29,400 "
Total weight	129,400 "
Dead load	22.72%
Live load	77.28%
Cost (approximate)	$730